ALASKA NATURAL GAS TRANSPORTATION SYSTEM

Final Environmental Impact Statement

SAN FRANCISCO

MARCH 1976

U.S. DEPARTMENT OF THE INTERIOR

WASHINGTON, D.C. 20240

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This final Environmental Impact Statement has been prepared under the provisions of Section 102(2)(C) of the National Environmental Policy Act of 1969 (P.L. 91-190). Contact regarding the document should be addressed to:

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SUMMARY

( ) Draft   (x) Final Environmental Statement
United States Department of the Interior, Alaska Natural Gas Transportation System EIS Task Force

1. Type of action: (x) Administrative   ( ) Legislative

2. Brief description of action: Action pending is granting rights-of-way permits for crossing Federal lands. A 5,580-mile buried pipeline has been proposed to transport natural gas from Prudhoe Bay (Alaska) to markets in the lower United States. The pipeline, as proposed, would cross all, or portions of, Alaska; Yukon Territory, Northwest Territories, British Columbia, Alberta, and Saskatchewan (Canada); and Idaho, Washington, Oregon, California, Montana, North Dakota, South Dakota, Minnesota, Iowa, Illinois, Indiana, Ohio, West Virginia, and Pennsylvania. As proposed, all activities necessary for pipeline construction and operation will be phased over a seven-year period. Of all lands traversed by the proposal, 406 miles will involve lands under the jurisdiction of five Federal agencies, all of whom have permitting authority. Other permits or licenses also must be issued before construction may begin or the project becomes operational.

3. Environmental impact and adverse environmental effects: Because of the linear nature of the proposal, a wide spectrum of environmental impacts will occur if the pipeline is built. Impacts, which are detailed in the Overview and geographically-oriented volumes, will occur on climate, topography, geology, soils, water resources, vegetation, fish and wildlife, social and economic environments, land use and productivity, cultural resources, recreation and esthetics, and air quality (including noise). All impacts will not be adverse.

4. Alternatives considered: Alternatives covered include the courses of action open to the Secretary of the Interior to approve, deny, postpone, or accept and delay or deny part of the proposal; effects of gas deregulation and conservation; other natural gas sources; alternative energy sources and modes of transportation; and one major alternative transportation system involving an all-Alaska gas pipeline, liquefaction plants, and LNG tanker transport to the conterminous United States.

5. Comments have been received from the following: Comments were received from 23 Federal agencies, 35 State and local governments, Canada, 17 companies representing industry, 16 private organizations, 100 individual citizens, and three members of Congress. Comments from Federal agencies, State and local governments, Canada, private organizations, and members of Congress are reproduced in the Consultation and Coordination volume. Other comments will be reproduced and filed as a supplement to this statement at selected repository sites.

6. Date made available to CEQ and the public:

Draft statement: July 28, 1975
Final statement: MAR 1976

Note for Readers

This environmental impact statement was prepared in response to applications made to the Secretary of the Interior for permits to cross Federal lands with a natural gas pipeline. It identifies and evaluates environmental impacts that could be expected from construction and operation of the "Alaska Natural Gas Transportation System" as proposed by the consortium of companies listed in the Consultation and Coordination volume. It was prepared by an interdisciplinary team, most of whom are employees of the United States Department of the Interior.

Detailed construction designs and detailed plans for site restoration and system operation are not complete at this (proposal) stage of the project. For this reason, some of the impacts and mitigating measures are expressed in ranges of magnitude or qualified to reflect alternative situations.

The Secretary of the Interior considers a number of factors in reaching his decision regarding issuance or denial of right-of-way permits. The environmental impact analysis presented in this statement is an important but not necessarily the deciding factor. Alternative gas transportation systems proposals, United States-Canada diplomatic relations, national economic and risk analyses, national defense implications, energy efficiency analyses, and other factors must also be considered.

This statement is presented in nine volumes as follows:

- Overview Volume
- Alaska Volume
- Canada Volume
- San Francisco Volume
- ~~Los Angeles Volume~~
- North Border Volume
- Alternatives Volume
- Consultation and Coordination Volume
- Glossary Volume

Witness and Comments and Responses

Alaska, Canada, San Francisco, Los Angeles and North Border Volumes are geographically oriented. The Overview Volume, Alternatives Volume, and Consultation and Coordination Volume are not geographically oriented in their coverage.

The following subject groupings are covered sequentially in each of the geographically oriented volumes and Overview:

1. Description of the proposal.
2. Description of the environment.
3. The environmental impact of the proposed action.
4. Mitigating measures proposed and additional measures considered.
5. Adverse effects which cannot be avoided should the proposal be implemented.

6. The relationship between local short-term uses of (man's resources) and the maintenance and enhancement of long-term productivity.
7. Irreversible and irretrievable commitments of resources associated with the proposed action.
8. Alternatives to the proposed route.

The reader can review particular segments of the proposed project selectively. For example, a reader interested only in impacts on North Dakota, could use the Overview Volume for the system "big picture," and the North Border Volume for coverage of his particular State. Similarly, a person interested primarily in ways of transporting natural gas could refer to the Alternatives Volume and satisfy his needs.

Following is a brief description of the coverage of each part:

<u>Overview Volume</u> - The Overview covers the Arctic Gas System proposal in its entirety. It will be most useful to those readers who want a system view and a broad concept of anticipated environmental impacts of the entire pipeline project.

<u>Alaska Volume</u> - This volume covers the 195-mile proposal of the Alaskan Gas Arctic Pipeline Company originating at Prudhoe Bay and terminating at the Alaska-Yukon Border and alternative routes.

<u>Canada Volume</u> - This portion of the environmental impact statement analyzes the 2,435-mile pipeline proposal of Canadian Arctic Gas Pipeline, Ltd., beginning at the Yukon-Alaska Border and proceeding generally southward to Caroline Junction in Alberta where it forks, one leg entering Idaho, near Kingsgate, British Columbia, and the other entering Montana, near Monchy, Saskatchewan. Discussions of route alternatives are also presented.

<u>San Francisco Volume</u> - This volume analyzes the 917-mile portion proposed by the Pacific Gas Transmission Company which passes through Idaho, Washington, and Oregon to Antioch, California. Discussions of route alternatives are presented.

<u>Los Angeles Volume</u> - This volume relates to the 414-mile portion proposed by Interstate Transmission Associates (Arctic) extending from the point of United States entry in Idaho to Rye Valley, Oregon. It also involves modifications to existing compressor stations in Oregon, Idaho, and Colorado. Discussions of route alternatives are presented. This volume also contains a discussion of

the applicant's future proposal for an additional 760-mile pipeline passing through Idaho, Oregon, Nevada, and terminating at Cajon, California.

North Border Volume - This volume is an analysis of the 1,619-mile pipeline proposed by the Northern Border Pipeline Company. It covers the area from the United States-Canada border, crossing Montana, North and South Dakota, Minnesota, Iowa, Illinois, Indiana, Ohio, and West Virginia, to a termination near Delmont, Pennsylvania. Discussions of route alternatives are presented.

Alternatives Volume - This volume covers courses of action open to the Secretary of the Interior to approve, deny, postpone, or accept and delay or deny part of the proposal; effects of gas deregulation and conservation; other natural gas sources; alternative energy sources and modes of transportation; and one major alternative gas transportation system involving an all-Alaska gas pipeline, liquefication plants and tanker transport to the conterminous United States.

Consultation and Coordination - This volume describes and discusses the efforts made by the Department of the Interior to consult with and coordinate its work in the development of this statement. It includes the gathering of basic information for analysis, public meetings, public hearings, and efforts which have and will be made to assure that environmental impacts are adequately treated.

Glossary - This volume provides the reader with definitions of technical words or phrases used in the environmental impact statement.

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1 <u>DESCRIPTION OF THE PROPOSED ACTION</u>

1.1 ARCTIC GAS PIPELINE PROJECT

1.1.4 <u>San Francisco Pipeline</u>

1.1.4.1 Introduction

The San Francisco Pipeline (Kingsgate to San Francisco) is a part of the proposed Alaska Natural Gas Transportation System (ANGTS) which will initially transport 4.50 bcf/d (billion cubic feet per day) of natural gas, 2.25 bcf/d from the Prudhoe Bay Field in Alaska and 2.25 bcf/d from the Mackenzie Delta area of the Northwest Territories, Canada, to industrial and population centers in Canada and the United States. The revised applications are based on the assumption that the 2.25 bcf/d from MacKenzie Delta area will be transported to Canadian markets and the 2.25 bcf/d from Prudhoe Bay will be transported to market areas in the United States. The Canadian Arctic Gas mainline can deliver 4.50 bcf/d when fully powered, while delivery and supply laterals have greater capacity. The total capacity of connecting facilities applied for also exceeds 4.50 bcf/d. Quantities above this will require additional facilities.

The San Francisco Pipeline will provide transportation of natural gas from a point on the Canada-United States border near Kingsgate, British Columbia, and Eastport, Idaho, to Antioch, California, and will serve the market area of Pacific Gas and Electric Company (PG&E) in central and northern California. This pipeline is proposed by PG&E and Pacific Gas Transmission Company (PGT).

Since 1961 PGT has owned and operated a natural gas pipeline extending from Kingsgate to the Oregon-California border while PG&E has owned and operated one from the Oregon-California border to Antioch. The PGT pipeline supplies approximately 1.0 bcf/d of natural gas from Kingsgate to the Oregon-California border area. In addition, the PGT pipeline transports an additional 151 MMcf/d (million cubic feet per day) for delivery to Northwest Pipeline Corporation at various points in the States of Idaho, Washington, and Oregon. The present pipeline is referred to by PGT as the 980 design and has a design flow capacity of 980 MMcf/d.

PGT will receive its share of the natural gas from Prudhoe Bay at Kingsgate, B.C., where the proposed pipeline will interconnect with the Alberta Natural Gas Company Limited facilities. To transport the natural gas to California, a number of alternative pipeline designs have been submitted to the Federal Power Commission (FPC) by PGT. All of these involve the construction of a pipeline generally within the same right-of-way as the existing 911-mile PGT and PG&E pipeline. The applicants consider all of the pending designs as viable alternatives. The ultimate design used by the applicants will be determined when quantities of natural gas available for import are assured.

PGT has filed the following alternative designs with FPC: 2180 design (1,200 MMcf/d additional import); 1830 design (850 MMcf/d additional import); 1580 design (600 MMcf/d additional import); 1180 design (200 MMcf/d additional import).

The 2180 design is considered as the primary design system and is so addressed in this Environmental Impact Statement. The other designs are discussed as alternatives.

The 1,200 MMcf/d additional import in the 2180 design would serve PG&E's service area having about 2.5 million customers, which, in turn, affect a population of 8.6 million residents.

The applicant estimates that approximately 2.0 percent of the average daily delivery will be used for fuel for compressors and operation of the system.

Interstate Transmission Associates (Arctic) [ITA(A)] proposes to import 600 MMcf/d from Kingsgate, and deliver 250 MMcf/d to PGT at Stanfield, Oregon. There has been no agreement reached between ITA(A) and PGT regarding this proposal. This proposal calls for PGT to deliver 250 MMcf/d to PG&E at the Oregon-California border, and PG&E to deliver like volumes into the system of Southern California Gas Company in the Los Angeles area. Depending on when ITA(A) delivers this natural gas to PGT, some changes may be required to PGT and PG&E facilities between Stanfield, Oregon, and Antioch, California, to transport the 250 MMcf/d.

Refer to Overview, Section 1.OV.1 for additional discussion of the ANGTS and natural gas reserves.

1.1.4.2 Location

<u>Specific Route</u>

Origin and Terminus

Idaho

The proposed pipeline route (see Figures 1.1.4.2-1 and 2) originates at Milepost (M.P.) 0.0 on the International Boundary near Eastport, and will parallel the existing PGT and PG&E pipeline. The proposed route follows the Moyie River and crosses it eight times. (For a listing of river crossings, see Table 1.1.4.2-1.)

It then continues down the Moyie Valley, swings slightly westward to cross the Kootenai River at M.P. 24.0 near Bonner's Ferry. It crosses the Pend Oreille River at M.P. 61.5 west of Sandpoint, Idaho. South of Compressor Station 5, the proposed route emerges into the Spokane Valley.

Washington

The proposed route in Washington begins at M.P. 106.8, approximately 7 miles east of Spokane. The proposed route crosses the Spokane River east of Spokane at M.P. 110.9 and crosses the Snake River at M.P. 206.8 near the town of Starbuck. It crosses the Walla Walla River at M.P. 254.2 which is 6 miles north of the Oregon border.

Oregon

The proposed route enters Oregon at M.P. 260.3. It crosses the Umatilla River at M.P. 283.3. Approximately 15 miles southwest of Condon, it crosses the John Day River Canyon at M.P. 357.3. Near the John Day River Canyon in north central Oregon the proposed route leaves the existing right-of-way at valve 9-2, and for 21.4 miles proceeds along a new route. It rejoins the existing right-of-way near compressor station 10 (M.P. 368). See Figure 1.1.4.2-3.

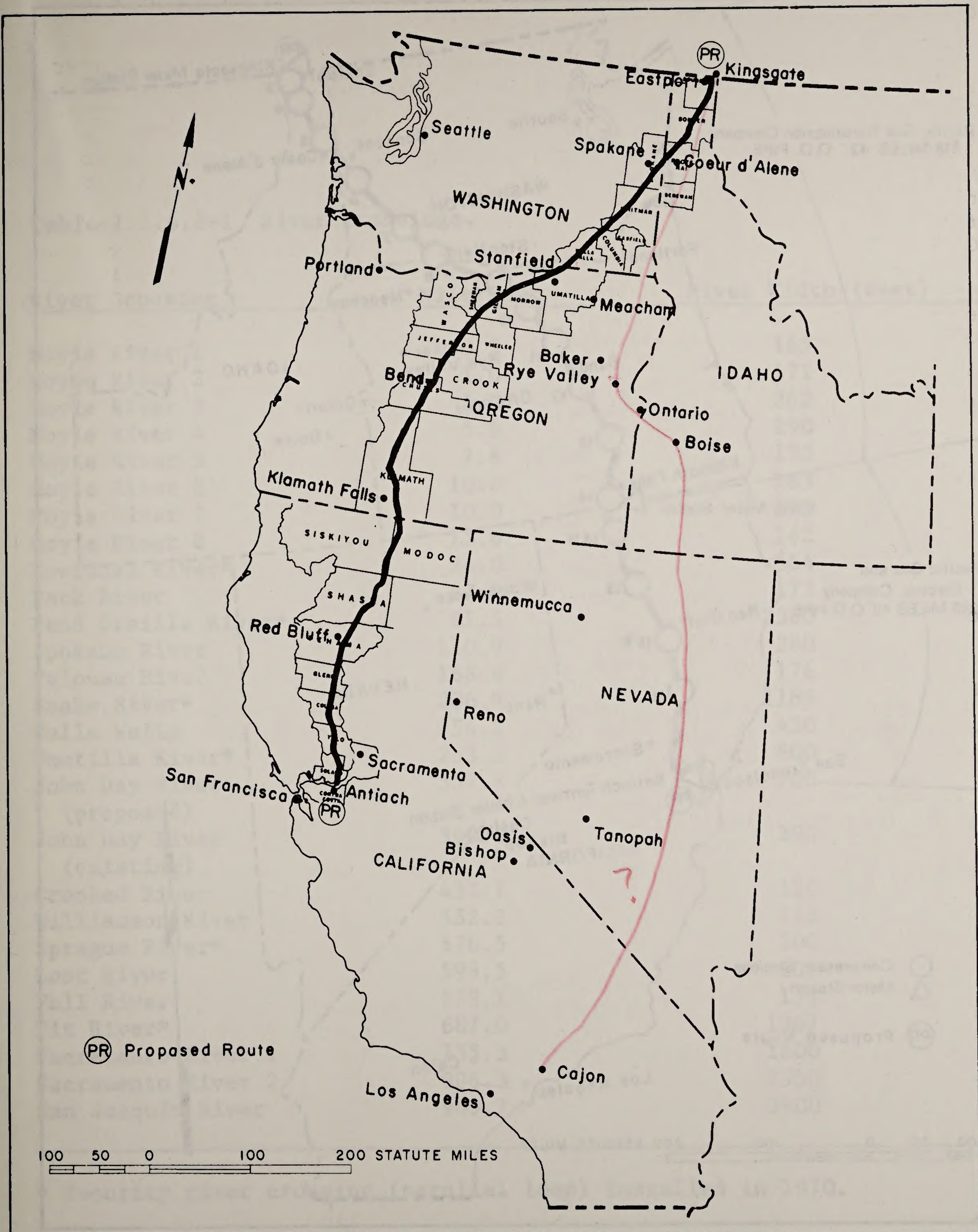


Figure 1.1.4.2-1 Project location map

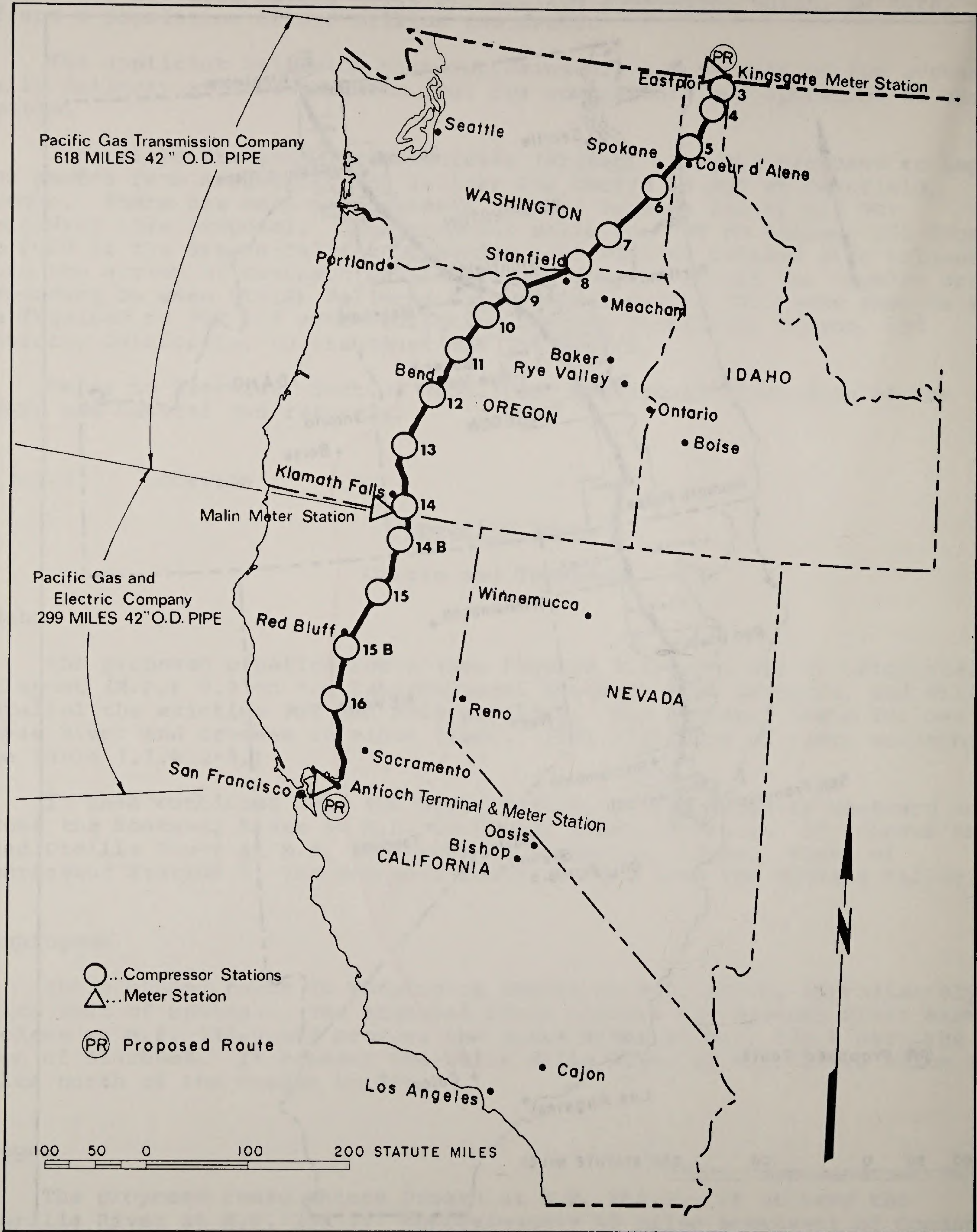


Figure 1.1.4.2-2 System map - Kingsgate to San Francisco

Table 1.1.4.2-1 River crossings.

River Crossing	Mile Post	River Width (feet)
Moyie River 1	0.3	165
Moyie River 2	1.0	171
Moyie River 3	5.0	282
Moyie River 4	5.8	290
Moyie River 5	7.8	173
Moyie River 6	10.0	183
Moyie River 7	10.0	195
Moyie River 8	13.6	142
Kootenai River*	24.0	664
Pack River	47.8	173
Pend Oreille River*	61.5	2360
Spokane River	110.9	380
Palouse River	168.6	176
Snake River*	206.8	1189
Walla Walla	254.2	430
Umatilla River*	283.3	600
John Day River (proposed)	357.3	700
John Day River (existing)	360.4	300
Crooked River	432.7	120
Williamson River	552.2	115
Sprague River*	576.5	200
Lost River	598.5	100
Fall River	679.1	159
Pit River*	687.0	1367
Sacramento River 1	755.3	1600
Sacramento River 2	906.3	2950
San Joaquin River	909.7	3900

* Security river crossing (parallel loop) installed in 1970.

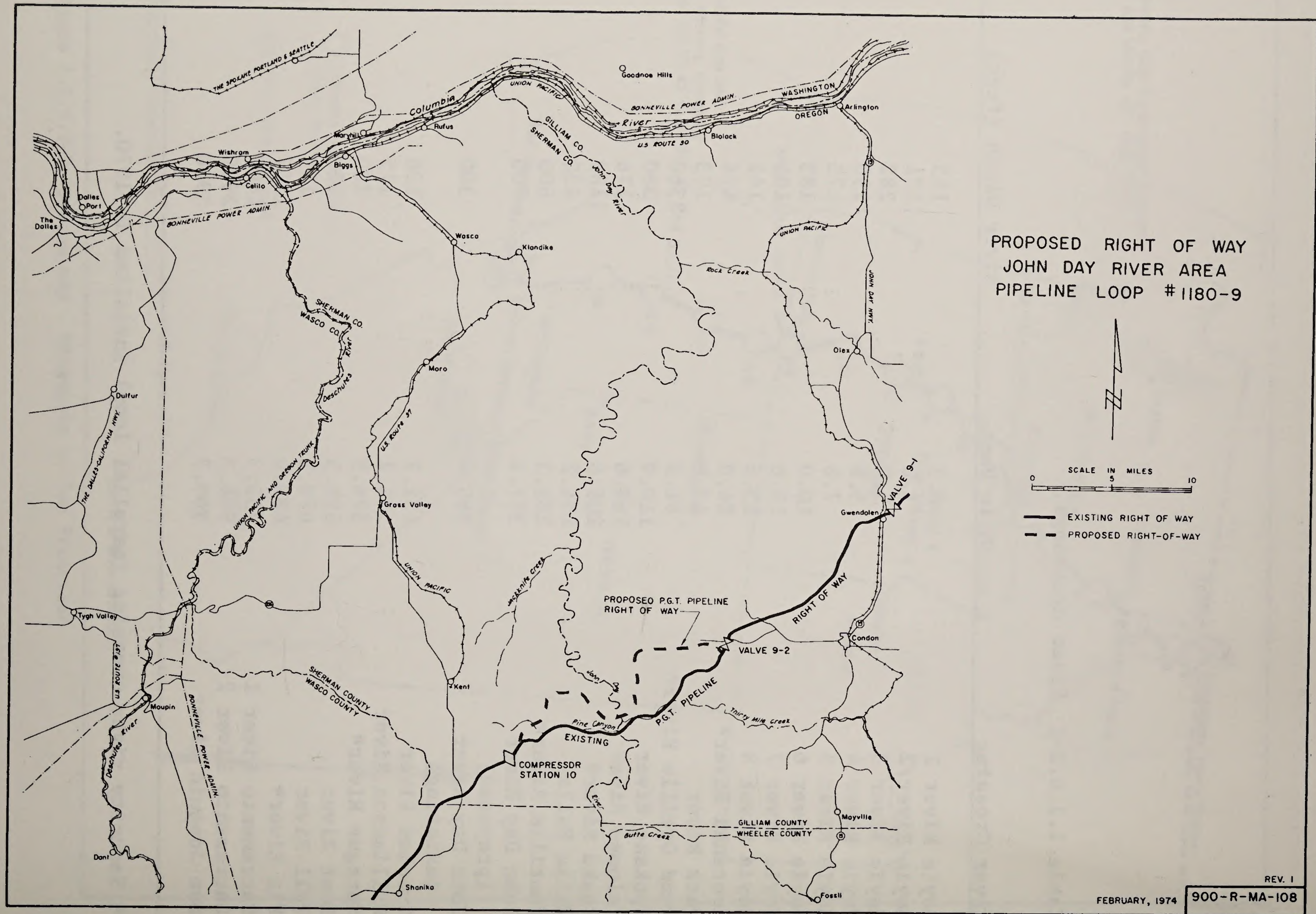


Figure 1.1.4.2-3 Proposed right-of-way, John Day river area

After leaving the John Day River Canyon, the proposed route passes near the towns of Shaniko, Madras, Redmond, and Bend.

It proceeds south, roughly paralleling U.S. Highway 97, enters the Winema National Forest at M.P. 516.3 north of Chemult and passes 8 miles east of Crater Lake National Park. The proposed route then proceeds eastward in a wide arc to follow the valleys of the Sprague and Lost Rivers. It crosses the Sprague River at M.P. 576.5 near the Oregon-California border. The proposed route leaves Oregon at M.P. 612.5 near Malin.

California

From the Oregon border to its southern terminus at Antioch, the existing pipeline is owned and operated by PG&E and is known as Line 400.

The proposed route proceeds south and crosses the Southern Cascade Mountains. The existing pipeline spans the Pit River on a bridge crossing at Lake Britton Reservoir near Fall River Mills at M.P. 686.8. (For aboveground sections of the existing pipeline, see Table 1.1.4.2-2.)

The proposed route crosses Battle Creek about 31 miles northwest of Red Bluff at M.P. 734.6, crosses the Sacramento River east of Red Bluff at M.P. 755.3, and then crosses Interstate 5 near Gerber.

After leaving the mountains, the proposed route enters the Central Valley between the Coast and Sierra Nevada mountain ranges. It proceeds along the west side of the valley near the towns of Winters and Vacaville.

Major crossings occur at the Sacramento (M.P. 906.3) and San Joaquin (M.P. 909.7) Rivers upstream from the point where the rivers join.

After the San Joaquin River crossing, the proposed route and the existing pipeline terminate at Antioch, M.P. 917, east of Highway 160 and north of the Southern Pacific Railroad tracks.

Specific Locations of Plants, Stations, and Related Facilities

The proposed design includes all facilities required for an ultimate 2,180 MMcf/d combined flow rate through the Applicant's proposed and existing pipeline system. The capacity of the existing system is 980 MMcf/d.

Auxiliary Facilities

Administration

PGT and PG&E corporate headquarters and executive offices are in San Francisco, California. PGT operating headquarters are in Spokane, Washington; PG&E in Antioch, California. No major additions are anticipated.

Communications

An existing microwave system will be used to monitor and control the flow of natural gas in the existing and proposed pipelines.

Table 1.1.4.2-2 Aboveground sections of the existing pipeline.

Location	Mile Post	Distance (feet)
Lake Britton (Pit River)*	686.8	1,200
Bear Creek	709.5	164
Snow Creek	724.0	108
Battle Creek	734.7	162
Tehama-Colusa Canal	755.8	261
Tehama-Colusa Canal	791.3	110
Lamb Valley Slough	860.0	69
Vaughn Canal	875.9	32
Mayberry Slough on Sherman Island	908.7	288

* Parallel loop installed under ground in 1971.

Compressor Stations

Additional compressor units will be added at four existing compressor stations to handle the increased flow of natural gas in the proposed pipeline. Specific locations are shown in Table 1.1.4.2-3.

In addition to the gas turbine-compressor units, other equipment needed at the compressor stations will include piping, valves, gas scrubbers, sound suppression equipment, a forced-draft gas after-coolers and station overpressure relief and blowdown valves.

Pressure Limiting Stations

It will be necessary to install additional pressure limiting or pressure relief facilities at some of the existing stations. These are located at M.P. 19.3, 160.2, 661.1, 727.8 and 846.4.

Meter Stations

The existing Malin Meter Station (M.P. 608) will be expanded for the 2,180 MMcf/d flow rate. Additions will include four meter runs with associated piping and valves, odorizing equipment, and a new meter building to house recording meters and telemetry equipment.

Pipeline Facilities

Crossties and Mainline Block Valves

Crossties between the existing and proposed pipelines will be provided. Mainline block valves will be the full opening type. It is possible that additional valving may be necessary to comply with the requirements of DOT (Department of Transportation) regulations. Blowdown lines and stacks will be installed at each valve location. Where necessary, valves near high-voltage electric power transmission lines will have the blowdown stacks located away from the lines to preclude possible accidental ignition of the natural gas.

Pipeline Markers

Identifying markers will be installed over the centerline of the proposed pipeline at intervals of about 1 mile. Additional markers will be placed at rivers, roads, fences, and public access crossings.

Cathodic Protection System

Pipeline protection from corrosion will be partly achieved by using a cathodic protection system. Test lead posts will be installed at 1- to 2-mile intervals along the pipeline. The cathodic protection system is explained in Section 1.1.4.7.

Mainline Taps and Interconnections

As an interstate common carrier, PGT transports natural gas to PG&E and for Northwest Pipeline Company (NPC). There are 20 delivery points along

Table 1.1.4.2-3 Locations of existing compressor stations.

Station Number	Name	M.P.	Type and Number of Turbine Units	Existing Combined Horsepower at Site Elevation and 80° F Ambient
3	Eastport	2.5	Jet (1)	11,750
4	Sandpoint	46.7	Industrial (2)	14,380
5	Farragut	87.6	Industrial (1) Jet (1)	20,430
6	Rosalia	143.5	Industrial (1) Jet (1)	20,620
7	Starbuck	212.6	Industrial (1) Jet (1)	21,410
8	Wallula	255.6	Jet (2)	25,420
9	Ione	319.5	Industrial (1) Jet (1)	21,125
*10	Kent	368.3	Jet (2)	23,500
11	Madras	425.1	Industrial (2)	14,620
*12	Paulina	472.8	Jet (2)	22,220
*13	(Diamond Lake (Junction	529.5	Jet (2)	21,960
*14	Bonanza	599.2	Industrial (1) Jet (1)	18,185
14B	Tionesta	637.1	Jet (1)	11,100
15	Burney	694.8	Industrial (1) Jet (1)	19,950
15B	Gerber	761.7	Jet (1)	12,830
16	Delevan	810.4	Industrial (2)	18,780

*Additional compressors must be added at these stations to achieve total capacity of the proposed 2180 mm cf/d system.

the existing pipeline in Idaho, Washington, and Oregon. These delivery points will be crosstied to the proposed pipeline in order to insure continuity of service at the tap locations (Table 1.1.4.2-4). PG&E delivery taps are shown in Table 1.1.4.2-5. PGT and NPC maintain an interconnection at M.P. 277.4 near Stanfield, Oregon. Gas from one pipeline may be diverted to the other under emergency conditions. This interconnection will be crosstied to the proposed pipeline. No aboveground structures other than valves and additional fencing will be required.

Relationship to Existing or Potential Energy Sources/Systems

The proposed pipeline is one of three pipelines to be constructed in the United States to transport natural gas from the Alaskan and Canadian arctic areas to the lower 48 states. The other two pipelines will deliver natural gas to the Los Angeles area and to the north-central and northeastern United States. Detailed data can be found in the Overview volume.

1.1.4.3 Facilities

Pipeline Description

The Applicants have, since 1961, owned and operated a 36-inch natural gas pipeline occupying the right-of-way proposed to be used by the new pipeline. The existing pipeline has a design flow capacity of 980 MMcf/d. The Applicants have filed several alternative designs with the FPC. See Table 1.1.4.3-1. The transport capacity of each design is different to illustrate a flexibility for determining the optimum pipeline design once the final volumes of natural gas available for import are established. The number of compressor station additions will be dependent upon which design is selected. The various alternatives have been the subject of several filings with the Federal Power Commission by Pacific Gas Transmission Company in Docket No. CP74-241. These filings are summarized as follows:

1) Application filed March 21, 1974; 42-inch 1,440/1,250 psig design to import 1,200 MMcf/d; first stage of construction for import of 200 MMcf/d from Alberta; additional stages of construction as additional natural gas from Alaska and northern Canada becomes available.

2) Amended application filed March 3, 1975; 42-inch 1,440/1,250 psig design to import 1,200 MMcf/d to be constructed in one phase; alternative 36-inch 1,440/1,250 psig design to import 850 MMcf/d.

3) Supplement to amended application filed July 16, 1975; alternative 36-inch 911 psig design with looping between existing compressor stations to transport an additional 200 MMcf/d; alternative 36-inch 911 psig design with completed parallel sections between existing compressor stations to transport an additional 600 MMcf/d.

The Applicants believe all of the pending designs are viable alternatives for transporting arctic gas to the Pacific Gas and Electric Company market area. In each of the designs indicated above, the same routing of pipe and locations of facilities have been proposed.

The pipeline as proposed would be approximately 917 miles long and 42 inches in diameter. The applicants indicate pipe wall thickness varies from 0.561 to 1.022 inches, depending upon design pressures. The design pressures vary from 1,440 to 1,250 psig for various segments and class locations as defined by Title 49, paragraph 192.111 of the U.S. Code.

Table 1.1.4.2-4 PGT-NPC delivery taps.

Tap Name	Milepost	Area Served	Maximum delivery* (MMcf/d)
Bonners Ferry	27.0	Bonners Ferry, ID	0.707
Sandpoint	86.3	Sandpoint, ID	1.752
Rathdrum	97.6	Rathdrum, ID	.097
Spokane	108.3	Spokane, WA	131.602
Spangle	134.2	Spangle, WA	.231
Rosalia	145.7	Rosalia, WA	.209
St. John	158.9	St. John, WA	.228
LaCrosse	182.8	LaCrosse, WA	.185
Stanfield	284.4	Stanfield, OR	.058
Madras	410.2	Madras, OR	1.278
Prineville	426.9	Prineville, OR	1.005
Redmond	438.3	Redmond, OR	2.141
Bend	454.5	Bend, OR	4.900
Stearns	469.2	Sun River, OR	.550
Gilchrist	501.0	Gilchrist, OR	.296
Crescent	504.4	Crescent, OR	.100
Chemult	519.4	Chemult, OR	.040
Beaver Marsh	524.4	Industrial Tap	.554
Diamond Junction S.	530.6	Industrial Tap	.173
Klamath Falls	599.1	Klamath Falls, OR	5.624

*As shown in 29th revision of EPNG-PGT Service Agreement.

Table 1.1.4.2-5 PG&E delivery taps.

Tap Name	Mile Post	Area Served	Design Delivery (MMcf/d)
Glenburn	680.6	Glenburn, CA	0.01
McArthur-Fall River	681.8	McArthur, Fall River, CA	0.11
Lorenz Lumber Co.	689.5	Industrial Tap	0.25
Johnson Park	693.4	Johnson Park, CA	0.14
Burney	694.8	Burney, CA	0.80
Publisher's Forest Products	698.0	Industrial Tap	.044
Black Butte School	726.8	Schoolhouse	Less than 0.01
Redding-Calaveras	741.9	Redding, CA	15.00
Sunsweet Dryer	752.3	Industrial Tap	Seasonal
Antelope	753.5	Antelope, CA	0.29
Rawson	756.9	Rawsons, CA	0.43
Gerber	760.2	Gerber, CA	0.13
Gerber Compressor Station	761.7	Eureka & Arcata, CA	22.00
Maxwell	816.5	Maxwell, CA	0.13
Buckeye Creek PLS	846.4	Sacramento Valley	30.00
Mariani	868.3	Mariani, CA	0.05
Main 159 Crossover	870.8	Winters, CA	1.00
American Foods Corp.	882.0	Industrial Tap	1.01
Creed Station	894.1	Napa Wye (North Bay, Marin Co., CA)	160.00

Table 1.1.4.3-1 Estimate of construction cost of facilities (July 1, 1975), alternate designs.

	2180 Design	1830 Design	1180 Design	1580 Design
PGT	$499,132,000	$381,406,000	$138,589,000	$252,770,000
PG&E	238,000,000	165,000,000	69,000,000	140,000,000
Totals	$737,132,000	$546,406,000	$207,589,000	$392,770,000

Source: Additional prepared Testimony of Witnesses, Nov. 3, 1975:
Philip E. Reynolds (PGT) and Charles J. Tateosian (PG&E)
United States of America before the Federal Power Commission: Docket Nos. CP74-241
CP74-242
CP71-182
CP75-252

Mainline pipe will be fabricated by rolling plate and welding using the double submerged arc process. All fabrication and testing is specified to be in accordance with the latest American Petroleum Institute (API) Standard 5 LX, for high-test line pipe. The basic pipe material will be API grade X-65 steel. The yield and tensile strengths of this pipe are given as 65,000 and 77,000 psi, respectively. All valves and fittings used will be fabricated and tested in accordance with: American National Standards Institute, publication B31.8; American Society for Testing and Materials (ASTM), publication A381; Manufacturer's Standardization Society, publication SP-75; API standard 6D; and ASTM publication E23.

Operating Pressure and Temperature

All proposed mainline pipe from M.P. 0.0 to 472.8 will have a maximum allowable operating pressure (MAOP) of 1,440 psig. From M.P. 472.8 to 810.3 the MAOP is 1,250 psig; and from M.P. 810.3 to the terminus of the line it is 1,040 psig. The MAOP matches the mainline MAOP at compressor station locations.

The pipeline is designed for the following average gas flow temperatures:

	Winter	Summer
Average ambient temperature	45° F	80° F
Average flowing gas temperature	45° F	65° F

The temperature of the gas stream as it moves through the pipeline will vary throughout the length of the pipeline and with the season of the year. The gas temperature in the existing pipeline varies from 120° F immediately downstream of a compressor station during the summer months to 35° F immediately upstream of a compressor station during the winter. When the gas passes through the centrifugal compressor, its temperature and pressure are increased. Consequently, the gas would be required to pass through a cooler to reduce its temperature prior to leaving the station.

Loops and Laterals Description

Approximately 44 miles of 36-inch O.D. pipeline has been installed parallel to the existing pipeline. This includes three sections totaling 38.4 miles presently in service and 5.6 miles in several short sections not in service. The applicants originally proposed to construct the 42-inch parallel pipeline in stages; however, this was amended to include all construction in one phase.

Description and Operating Characteristics of Plants, Compressor Stations and Related Facilities

Treatment, Measurement, and Compression

Existing Facilities

PGT and PG&E own and operate a 36-inch O.D., 911 psig pipeline that extends a distance of 911 miles from the Canadian-United States border near Kingsgate, British Columbia, through the States of Idaho, Washington, Oregon, and California.

Sixteen compressor stations are already on the existing pipeline (Table 1.1.4.2-3 and Figure 1.1.4.2-2).

Proposed Facilities

To achieve the design capacity of the proposed system of an additional 1,200 MMcf/d of imported gas, PGT proposes to install four additional compressors at existing station sites shown in Table 1.1.4.2-3. Centrifugal compressor aerodynamic assembly changes will be required on 13 existing units at nine existing stations.

Additional metering facilities are proposed at the Malin meter station.

Plant Sites and Buildings

The support and maintenance sites and buildings for the existing 36-inch pipeline will also serve the proposed pipeline.

A maintenance base and headquarters of the PGT Northern Area and Sandpoint District are located at compressor station 4. A maintenance base and headquarters of the PGT Rosalia District are at compressor station 6. A maintenance base and headquarters of the PGT Central Area and Wallula District are at compressor station 8.

A maintenance base and headquarters of the PGT Redmond District are in Redmond, Oregon. A maintenance base and headquarters of the PGT Southern Area and Klamath Falls District are in Klamath Falls.

The Oregon-California Border meter station, where PGT measures and records volume of gas delivered daily to PG&E, is near Malin, Oregon. The existing odorizer for PG&E is also at Malin.

In California, a maintenance base is combined with PG&E's Electric and Water Distribution offices in the town of Burney. Other maintenance bases are located in Willows and Antioch, California.

<u>Cost of Facilities</u>

Total cost for the proposed 42-inch pipeline and related facilities was estimated by the companies on July 1, 1975, to be $737,132,000. Table 1.1.4.3-1 shows the Applicant's cost estimates of the various design alternatives.

1.1.4.4 Land Requirements

<u>Right-of-Way</u>

Permanent

The existing pipeline is installed on a 100-foot right-of-way on private lands and a total 50-foot wide right-of-way on Federal lands. See Table 1.1.4.4-1 for estimated total land requirements. The proposed pipeline will be offset 20 to 30 feet from the existing pipeline (centerline to centerline), depending on topography.

The centerline of the existing pipeline is located 30 feet from the edge of the 100-foot right-of-way across private lands. For the most part the applicant intends using the remaining 70-feet fo• the proposed pipeline. Approximately 85 percent of the proposed pipeline will be located on private lands.

Table 1.1.4.4-1 Total right-of-way land requirements. 1/

	Federal	Private	Totals
Miles	139.91	777.09	917.00
Acres			
Permanent	971.61 4/	9,418.33 3/	10,389.94
Temporary	544.01 2/	None	544.01
Total	1,515.62	9,418.33	10,933.95

1/ Subject to minor adjustments due to recent land ownership changes and to yet to be determined pipeline centerline location.

2/ Based on PGT 25' temporary R/W; PG&E 40' temporary R/W.

3/ Based on clearing 100' of existing 100' pipeline R/W owned by Applicants across private lands.

4/ Federal lands include:

	Miles		Acres	
U.S. Forest Service				
Kaniksu	6.18		58.60	
Ochoco	20.09		190.93	
Deschutes	30.54		292.09	
Winema	11.36		107.18	
Modoc	15.21		284.96	
Shasta Trinity	16.94		188.83	
Lassen	1.85		21.08	
Subtotal		102.17		1,143.67
Bureau of Land Management				
Idaho	0.28		2.69	
Oregon	34.35		334.64	
California	2.60		29.11	
Subtotal		37.23		366.44
Dept. of the Army	0.51		5.51	
Total (Federal)		139.91		1,515.62

Note: Data are based on the application. The total acreage requirements above are considered the maximum amount of lands to be disturbed during the construction period. Total acreage will be reduced by:

a. For a 42" pipeline offset 20 to 30' from the existing pipeline, there will be an overlap of from 21 3/4 to 25' of the existing permanent right-of-way totaling about 500 acres.

b. In most instances the company plans to operate within a 70 foot width of its existing 100 foot permanent right-of-way across private lands.

The total width of the proposed new right-of-way across Federal lands is 50 feet plus the diameter of the pipeline, or 53.5 feet. Since the applicants propose to parallel and offset between 20 and 30 feet from the existing pipeline, the additional width that will be added to the existing 50 foot right-of-way will be 21.75 to 31.75 feet. See Figure 1.1.4.4-1. In the case of a 20-foot offset, the total permanent right-of-way across Federal lands for both pipelines will be 71.75 feet. Consequently for the 20-foot offset, 21.75 feet will be added to the existing permanent right-of-way.

The new routing across the John Day River is 21.4 (5.3 Federal and 16.1 private) miles long and runs between M.P. 346.9 and 368.3. Acreages required for this new routing are included in Table 1.1.4.4-1.

Temporary

In addition to the permanent right-of-way, there is a need for an additional 25 to 40 feet of temporary right-of-way as work areas across Federal lands. On Federal lands the temporary right-of-way will be immediately adjacent to the permanent right-of-way. On private lands most of the land requirements for temporary working areas will be within a 70-foot strip on the existing 100-foot permanent right-of-way.

It will be necessary to use additional working areas at several of the major river crossings. These areas would be used only during construction. Temporary work areas will be needed at crossings of the following rivers:

Moyie River 1-8	2.4 acres total (8 crossings; 0.28 acres per crossing)
Fall River	1.0 acre
Sacramento River (N)	1.7 acres
Sacramento River (S)	6.4 acres
San Joaquin River	4.8 acres

Five additional temporary work areas totaling 24.33 acres at five sites will be required for the John Day River section.

A number of temporary pipe stockpiling yards, double-jointing yards, or both, will be located near railheads. However, the number, location, size, and exact nature of these yards have not been determined. Pipeline contractors will also require temporary staging and storage areas for their heavy equipment and excavated materials, with the location and size dependent on construction plans.

<u>Plant, Station, and Related Facility Site Acreage</u>

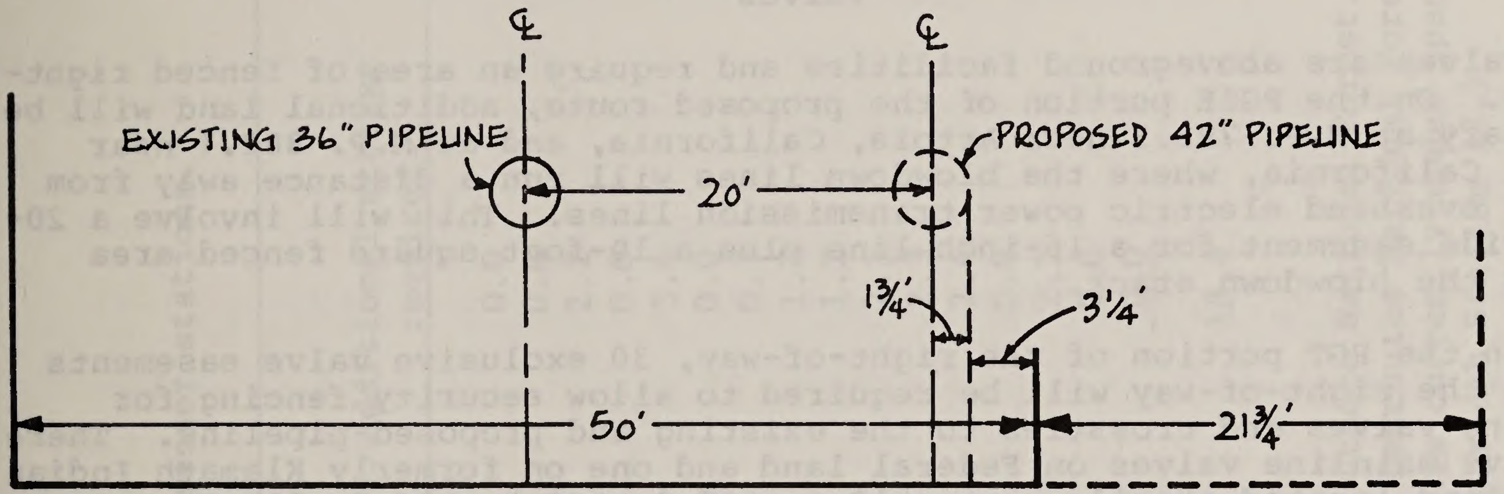
Compressor Stations

Most of the existing compressor stations have adequate space to increase the number of compressor units. The 16 existing compressor stations now utilize a total of 81 acres. An additional land usage of 16 acres (property already owned or leased) for a total of 97 acres will cause no relocation of houses, commercial or industrial facilities.

CROSS SECTION OF PERMANENT R/W LAND REQUIREMENTS

FOR 20' SEPARATION OF EXISTING

AND PROPOSED PIPELINES



——— EXISTING R/W

– – – PROPOSED R/W

NOTE: On a 20' parallel pipe separation (℄ to ℄), the extension of the existing R/W will be 21 3/4'. For a 30' separation, the extension will be 31 3/4'. The existing R/W is 50' total width; the proposed R/W is 50' plus the diameter of the pipe.

Construction requires additional 25' to 40' temporary R/W.

Figure 1.1.4.4-1 Cross section of permanent right-of-way land requirements for 20 foot seperation of existing and proposed pipelines

Some of the existing properties will be cleared and refenced. Extending the fence line approximately 100 to 200 feet will be necessary at stations 5, 9, 10, 11, 13, 14 and 15. Clearing of trees will be necessary at stations 5, 12, 13 and 15. A new access road will be required for station 4.

Station 12 is located within the Deschutes National Forest in Deschutes County, Oregon. An amendment of PGT's Special Use Permit will be required for additional clearing and extension of the fence line approximately 200 feet southward to allow grading and construction.

It will be necessary to purchase and grade approximately 5 acres of additional privately owned land adjacent to compressor station 7 in Walla Walla County, Washington, to permit station expansion there. Compressor station acreage requirements are shown in Table 1.1.4.4-2.

Valves

Valves are aboveground facilities and require an area of fenced right-of-way. On the PG&E portion of the proposed route, additional land will be necessary at M.P. 793.3 near Artois, California, and at M.P. 882.1 near Dixon, California, where the blowdown lines will run a distance away from nearby overhead electric power transmission lines. This will involve a 20-foot-wide easement for a 16-inch line plus a 10-foot square fenced area around the blowdown stack.

On the PGT portion of the right-of-way, 30 exclusive valve easements within the right-of-way will be required to allow security fencing for mainline valves and crossties to the existing and proposed pipeline. There are five mainline valves on Federal land and one on formerly Klamath Indian Tribe land located at mile posts 410.2, 437.0, 460.4, 486.5, 516.5, and 562.1. Valve easements will be acquired from private landowners and special use permits from government agencies.

It will also be necessary to purchase about 0.5 acre of additional private land at mainline valve 8-2 (M.P. 277.4) to allow for valve and crosstie installation and security fencing. This mainline valve location is the PGT emergency intertie connection with NPC mainline. At mainline valve 5-2 (M.P. 108.3), 3.5 acres of additional land have been acquired for the valving installation and crosstie for the Spokane tap.

Pressure Limiting Stations

It will be necessary to acquire additional exclusive easements for each of the pressure limiting and pressure relief facilities.

Related Land Areas Affected

Roads

The Applicants indicate that construction activities will utilize existing roads, including the access provided by the existing pipeline right-of-way. Approximately 1 mile of new access roads will be required in the John Day River Canyon.

Table 1.1.4.4-2 Acreage requirements for compressor stations.

Station number	Total acreage owned or leased	Total acreage in use (fenced) as of June 30, 1973	Additional acreage required	Total acreage required	Remaining acreage unused
3	41.9	3.4	0.0	3.4	38.5
4	45.8	7.3	0.0	7.3	38.5
5	40.0	4.2	2.2	6.4	33.6
6	39.0	9.1	0.0	9.1	29.9
7	67.6	5.0	3.4	8.4	59.2
8	45.6	6.3	0.0	6.3	39.3
9	38.9	3.6	0.7	4.3	34.6
10	39.2	2.9	1.7	4.6	34.6
11	35.1*	3.7	1.2	4.9	30.2
12	5.5**	3.9	2.3	6.2	0.0
13	33.5	5.9	2.3	8.2	25.3
14	39.7	3.8	2.4	6.2	33.5
14B	14.6***	5.6	0.0	5.6	9.0
15	26.7	4.2	2.2	6.4	20.3
15B	11.6	6.1	0.0	6.1	5.5
16	29.8	6.5	0.0	6.5	23.3
Totals	554.5	81.5	18.4	99.9	455.3

* Station 11 is on a Special Use Permit in the Ochoco National Forest.
** Station 12 is on a Special Use Permit in the Deschutes National Forest. (0.7 acres of land is needed over that which is currently under Special Use Permit at Station 12. This extra land is part of the right-of-way through Station 12.)
*** Tionesta (14B) is on a Modoc National Forest Land Special Use Permit.

Housing

The Applicants indicate there will be no displacement or relocation of homes or businesses as a result of pipeline construction. Construction of buildings or other structures on the permanent right-of-way will not be allowed.

1.1.4.5 Schedule

Duration and Phasing of Project Construction

Construction is planned to begin approximately 1 year after the necessary approvals for construction are received from Federal, State, and local administrators identified in Section 1.1.4.9.

Individual Facility Construction Times

The Applicants have not identified a time frame for individual facility construction. It is assumed that related facilities would be constructed concurrently with pipeline construction.

Time Required for Preparatory Functions

Relocation of Housing, Business, and Public Facilities

No relocation of housing, business, or public facilities is anticipated.

Before construction, the Applicants will be required to obtain permits to encroach upon rights-of-way of public facilities.

Road Crossings

No time frame has been provided, since permits from Federal, State, and county highway agencies will be required prior to construction of road crossings.

Maintenance of Public Services During Construction

Except where open cut is permitted by the landowners, all railroad and road crossings of the pipeline at interstate and major county roads will be tunneled or bored to avoid interference with traffic. County road crossings may be open trench construction. The time period needed for traffic detours at these minor county crossings will usually be 1 or 2 days.

At canal crossings the pipeline will be tunneled or bored in a manner similar to that for major highway crossings or aboveground sections will be constructed. Aboveground sections will be constructed at nine existing aboveground locations between mileposts 686 and 909 (Table 1.1.4.2-2).

Schedule of Currently Proposed Construction

In the applicant's original proposal, construction would have commenced approximately 1 year after necessary approvals had been received and would

be in phases. The amended application indicates construction will be in one phase.

1.1.4.6 Construction Procedures

Preparatory Procedures

Survey and Design

The entire proposed route will be surveyed for the new pipeline. Site-specific profiles and engineering design will be made of significant areas such as streams, rivers, highways, irrigation facilities, and other crossings.

Roads and Site Clearing

Access Roads and Work Areas

Access roads built for construction of the existing pipeline will be used in constructing the proposed pipeline. All access roads and temporary construction roads will be constructed and graded with the permission of landowners, or administering agencies.

Construction work areas, and access roads will be graded to provide access to the pipeline during construction, and to insure construction of the pipeline in a safe and efficient manner.

Clearing

The entire length of the pipeline right-of-way will be cleared to provide room for construction equipment. The work will be performed in accordance with permits and agreements with each landowner or administering agency.

Marketable timber will be logged prior to construction on the right-of-way. Bulldozers or brushdozers will be used to clear the land as required.

All tree limbs, tops, slash, and other debris will be disposed of by chipping or will be piled in existing open areas off the working strip. Following construction, the debris will be burned or otherwise disposed of as required by the administering agency or landowner.

Water Crossings

Field surveys followed by engineering design of each crossing will be necessary. All applicable State, county, and Federal permits must be obtained prior to construction.

Pipeline Construction Techniques

Excavation

The entire pipeline will be installed below ground, except for canal crossings where aboveground sections are required by owners or authorities. The existing pipeline is installed above ground at nine locations in California (Table 1.1.4.2-2).

Specifications

The size of the pipeline trench will depend upon the size of the pipe and the types of soil and bedrock through which the route would pass. Generally, the width of the pipeline trench will be approximately 12 inches greater than the outside diameter of the pipe. The depth of the trench must be sufficient to provide adequate cover over the pipe in accordance with DOT regulations. The trench will be deep enough to provide at least 30 inches of cover after the pipe is placed in the trench.

The bottom of the trench will be cleared of loose rocks and, when necessary, common excavation material or other suitable bedding material will be provided as a cushion for the pipe.

Trenching

Trench excavation on moderate terrain will be done using trenching machines or backhoes. River crossing trenches will be excavated using either a backhoe, dragline, or clamshell. In rock areas, a backhoe will be used to clean the trench after necessary blasting. Topsoils will be excavated separately from subsoils and stockpiled alongside the trench.

Blasting

When constructing the pipeline through rock areas, it will be necessary to drill, blast, and excavate the rock. Before blasting, prior notice will be given to landowners, adjacent landowners, property occupants, governmental agencies, adjacent work crews, and other interested parties.

Precautions may be necessary to prevent overbreak during blasting and to preserve the rock beyond the line of excavation. Flagmen will be posted at safe distances to protect the public and control traffic when blasting is done adjacent to public or private roads.

In some instances, loose rock or debris might be scattered over the right-of-way or removed to adjacent property. Safety in this construction phase will require experienced workmen to off-site test, supervise, handle, and use the explosives.

Additional Excavation

Additional excavation will be required at mainline valve crosstie lines and at compressor, meter, or pressure limiting stations or similar facilities.

Road Crossings

Where the pipeline route crosses roads, such crossings will be bored, except when trenching is permitted by the landowner or agency having jurisdiction. When a trench is made, temporary bridging will be installed for the full width of the road to accommodate the flow of traffic. Instead of bridging, the trench may be temporarily backfilled. All temporarily backfilled paved road crossings will have a cover of asphalt material in traveled areas as required by the State or local highway agency.

Water Crossings

Where the pipeline crosses watercourses, the streambanks will be graded to form a ramp to the water edge. Excavated material will be set aside and saved for restoring the banks after construction. Excavated material will be placed on the banks or in the riverbed downstream from the trench.

Concrete Lined Watercourses

Where the route will cross concrete lined canals or watercourses, the pipeline may be bored or installed in an overhead crossing.

Bridging Open Trenches

When the pipeline crosses cultivated land, temporary bridging may be necessary as required by property owners or tenants to move livestock and equipment across excavated trenches.

Pipe Installation

Specifications

The new pipeline will consist of about 917 miles of 42-inch O.D. welded steel pipe as required by DOT regulations. An external coating will be applied to the pipe to prevent corrosion. This will be done either at the manufacturer's plant, a special coating yard, or on the right-of-way. The corrosive character and water content of the soil, and the economics of the coating itself, will determine the method of coating and the location to be used. A selection of one or more of the following systems will be employed: asphalt and asphalt-saturated paper, somastic (asphalt and sand mixture), coal tar with coal tar saturated paper, polyethylene, Butyl tape, or thin film epoxy.

Hauling

Pipe will be shipped either directly from the manufacturer by rail or by truck to the site or shipped to the field plants for coating and doublejointing. In the latter case it will then be hauled to the right-of-way on trucks with specially designed cradles to prevent damage to the pipe and the coating.

Stringing

The pipe will be placed in a line parallel to the trench. This will be preparatory to bending, assembly, and welding.

Bending

A tracked hydraulic bending machine will bend pipes according to the configuration of the trench.

Stockpiling

Pipe will be stockpiled along the right-of-way. Stockpiled pipe will be blocked to prevent movement or rolling.

Field Jointing

After the sections of pipe have been bent at the trench sites, they will be welded together in accordance with approved Federal and State requirements. The welds will be inspected and the bare sections will be field coated for protection from corrosion.

Lowering

Pipe will be inspected before it is placed in the trench and all damaged portions of the protective coating will be rewrapped or repaired. The pipe will then be placed in the trench.

Backfilling

When the pipe is in place, backfill material such as fine earth or sand will be placed over its top. Selected backfill material may be obtained from approved borrow sites. The remainder of the trench will be filled with excavated or other native material, including a final coating with topsoil from the stockpile.

River Crossings

Sections of pipe designated for crossing a river or stream will be welded into a continuous string on the work area adjacent to the crossing, protectively coated for corrosion control, jacketed with concrete to provide negative buoyancy, then hydrostatically tested.

Divers may be used to inspect the bottom of the trench prior to installation of the pipe; pipe sections will be moved into the trench using sideboom crawler tractors, barges, pontoons, or other means, depending on the requirements of the specific locations.

The trench will then be backfilled. The graded ramp will be removed and channel banks and levees will be backfilled and compacted. Special measures such as riprapping breakers, cutoff walls, or rock facing on channel banks and levees for protection and restoration will be done as required by permits.

Cleanup

Because the pipe displaces a portion of the excavated material, not all of the original material removed can be returned to the trench. Therefore, the surplus soil will be evenly distributed over the right-of-way. When the excavation involves rock, surplus rock will be taken to previously designated disposal sites.

When needed, sack breakers and diversion ditches will be installed on hillside areas after installation of the pipeline. These techniques stabilize the soil and channel water runoff. After cleanup, disturbed areas will be reseeded, fertilized, and mulched as required.

Table 1.1.4.6-1 indicates the number and types of major equipment units that will probably be used in a typical pipeline spread. Exact numbers will vary with terrain, soil conditions, time allowed for construction, and with different contractors.

Construction Techniques for Plants, Stations, and Related Facilities

See Section 1.1.4.3. Since the existing facilities need only be expanded to accommodate the proposed pipeline, no unique construction techniques are planned. All planned construction techniques will comply with applicable Federal, State, and local agency requirements.

Testing Procedures

Hydrostatic Testing

After a segment of pipe is lowered into the trench, a pressure test will be made. Each segment will be tested to a pressure as specified by DOT 192 and/or CPUC (California Public Utilities Commission) General Order No. 112-C as applicable. The test pressure will be maintained for a minimum period of 8 hours. Should a leak or break occur, the line will be repaired and retested, until the required specifications are met. After testing, the test water may be pumped to the next section for testing. Pigs or spheres will be pushed through the line to remove the test water.

The section of pipe designated for crossing a river or stream will be welded into a continuous string adjacent to the crossing and hydrostatically tested prior to lowering it into the trench.

Quality Control and Welding Tests

Quality control of the pipeline construction will be accomplished through visual inspection, radiographic testing of girth welds, and hydrostatic testing. All work will meet the requirements of the CPUC General Order No. 112-C in California or DOT 192, Minimum Federal Safety Standards in other states.

Field girth welds will be radiographically inspected in accordance with regulations in DOT 192, subpart E, to assure the quality of the welds. The qualifications of welders and the welding procedures will comply with DOT regulations.

Work Force

Source, Type, Skill Level, and Number

According to the Applicants, construction of the proposed pipeline will require approximately 10 work crew spreads, each employing 250 to 300 people for an average period of 3 to 6 months. Based on pipeline construction experience, 75 percent of the labor force is considered skilled labor (welders, equipment operators, and foremen) and will be drawn from the nationwide market. The remaining 25 percent consists of unskilled labor and will be drawn from local labor forces. In addition, approximately 300 to 600 additional workers will be needed for administration, surveying, right-of-way acquisition, contract inspection, engineering, and other support functions.

Table 1.1.4.6-1 Typical major equipment used for large diameter pipeline construction.

CLEARING AND GRADING
2 Tractors, D-9, Dozer
2 Tractors, D-8, Dozer
1 Fuel Truck
1 Pickup Truck
1 Motor Patrol
1 Carryall

PIPE STRINGING
25 Pipe Trucks
1 Tractor, Pipelayer
2 Tractors, Tow
1 Truck, Gin Pole
1 Pickup, 4-Wheel Drive
2 Pickup Trucks

TRENCHING
1 Ditching Machine
8 Backhoes, 22B
1 Tractor, D-9, Dozer and Ripper
3 Tractors, D-7, Dozer
1 Tractor, D-8, Dozer
3 Carryalls
2 Tractors, Pipelayers
1 Front End Loader
3 Sets Twin Drills
4 Air Compressors
1 Truck
3 Pickups
1 Pickup, 4-Wheel Drive

LINE-UP, WELDING, LOWERING-IN
4 Buses
1 Fuel Truck
2 Fuel Wagons
1 Buffing Rig
7 Welding Rigs, Utility
3 Tractors, AC-16, Pipelayers
4 Tractors, AC-21, Pipelayers
1 Backfiller
2 Water Pumps, 6-Inch
2 Tractors, Tow
3 Trucks, Flatbed
18 Welding Rigs, Pipeline
2 Tack-Welding Rigs
1 Water Pump, 2-Inch
1 Truck, Tack Rig
1 Pickup Truck
1 Tractor, D-7
1 Tractor, D-8, Dozer
5 Float Barges
1 Air Compressor 125 cfm
1 Jet Pump

BENDING
1 Bending Machine
1 Tractor, HD-16, Pipelayer
1 Pickup Truck

WRAPPING
1 Tractor, D-7
2 Trucks, Flatbed
2 Pickup Trucks
1 Front End Loader

CLEANUP
1 Motor Patrol
1 Tractor
2 Tractors, D-8,
2 Tractors, D-7, Dozer
1 Truck, Flatbed
2 Pickup Trucks

MISCELLANEOUS
4 Trucks, Mechanic Rig
1 Truck, Grease
4 Trucks, Winch
1 Trailer, Float
3 Vans
1 Office Trailer
1 Trailer, Lowboy

Housing and Public Facilities Needed

The 250 to 300 work crew members for each 100-mile spread will need housing, food, personal services, and entertainment. Towns within a 100 mile radius of the pipeline are assumed to be able to accommodate increased retail sales and other services that will be generated by the work crew. Construction workers will probably make their own arrangements for temporary housing.

Those communities housing the construction workers and their families will experience a temporary increased demand for public services such as schools, health facilities, police and fire protection, recreation, waste disposal, utilities, and transportation.

It is not anticipated that temporary construction camps will be provided for construction personnel. No camps were used during the construction of the existing pipeline.

Occupational Safety and Health Act Procedures Applicable

The Applicants and their contractors will comply with all applicable provisions of OSHA (Occupational Safety and Health Act) that apply to construction and operation of the pipeline. Additionally, State laws which apply to the safety of workers must be observed.

1.1.4.7 Operational, Maintenance and Emergency Procedures

PGT and PG&E have operating and maintenance plans that comply with the Minimum Federal Safety Standards for Transportation of Natural and Other Gas by Pipeline (Part 192) issued by the DOT Office of Pipeline Safety, and with the applicable regulatory requirements of the States of Idaho, Washington, Oregon, and California. Similar plans will be developed for the proposed pipeline and facilities.

The Applicants state that other Federal, State, and local codes and regulations, such as those of OSHA will be followed in the operation and maintenance of the facilities.

The proposed pipeline will be designed so that all facilities can, in conjunction with the existing pipeline, be monitored, controlled, and operated in a safe and reliable manner through a telemetry system linked to two remote control centers. The facilities will not require full-time maintenance personnel at the sites, but these personnel will inspect compressor and delivery sites daily under normal operating conditions. The other facility sites will be checked on an established schedule.

Personnel will be housed along the system so they can reach any area within a short period of time in case of an emergency or malfunction. All equipment containing moving parts, such as compressor engines, will require periodic routine maintenance and major maintenance on a scheduled time-of-use basis.

The pipeline right-of-way will require scheduled surveillance for erosion damage and right-of-way encroachment. The pipeline will be monitored for corrosion control.

Technical and Operational Description

Valves, Controls, and Pipeline

All facilities will be monitored and operated under remote control through a communications link with two control centers. The mainline block valves at compressor stations will be equipped with automatically controlled power operators and can also be operated and monitored under remote control. These valves will be used to isolate pipeline segments between compressor stations in the event of a system failure.

Process and Treatment

The natural gas to be received at the International border will contain about 90 percent methane with small amounts of other hydrocarbons (ethane, propane, butane, isobutane, and pentane), nitrogen, and carbon dioxide. No processing or treatment facility has been identified by PGT or PG&E as necessary for the operation of the existing or proposed pipeline.

The existing odorizer station at Malin, Oregon, will be expanded as necessary; the proposed natural gas has no odor of its own. An odorizer facility adds an odorant (mercaptan) to the gas to give its characteristic smell. This is done as a safety measure to allow detection of escaping gas.

Maintenance Procedures

Corrosion Checks

Periodic surveys of the cathodic protection system will be made to verify the effectiveness of the system. The electrical output of the rectifier installations will be checked and readings taken of test leads attached to the pipe.

Whenever buried pipe becomes exposed, an inspection will be made of the pipe and its coating. When the pipeline must be cut for maintenance or reconstruction, the interior walls of the pipe will be inspected for evidence of corrosion.

Operating Surveillance

Pipeline

Aerial patrols and ground inspections of the proposed pipeline will be made with the same frequency as inspections of the existing pipeline system and will be conducted in compliance with the latest revision of Minimum Federal Safety Standards for Transportation of Natural and Other Gas by Pipeline (Part 192), issued by the DOT, Office of Pipeline Safety, and with the applicable regulatory requirements of the States of Idaho, Washington, Oregon, and California. Inspection intervals are set forth in company operating and maintenance policy.

The following inspection intervals will be used in the States of Idaho, Washington, and Oregon:

<u>Aerial</u> <u>Patrols</u>--Minimum frequency of once each month.

Surface Patrols--Facilities that cannot be observed properly by air patrol will be observed by surface patrol semi-annually or more frequently if necessary. Freeways, major highway crossings, railroad crossings, and major river crossings are inspected at intervals of about 3 months.

In the State of California, the minimum frequency for patrols will be monthly. Where an aerial patrol is performed, a ground patrol will also be made at least once each year.

Compressor Stations and Other Facilities

Compressor stations, pressure limiting stations, and other facilities will be routinely inspected at frequent intervals. This inspection and testing may involve testing controls and equipment which may result in brief periods of venting gas to the atmosphere.

All compressor stations and other critical facilities are under constant observation and surveillance by telemetry systems. This surveillance is conducted automatically by detection equipment and computer interrogation and manually by operating personnel headquartered at 24-hour attended control facilities. Equipment malfunction can be detected and corrective action can be initiated from the control headquarters.

Leaks

Leak surveys will be conducted routinely to detect possible pipeline leaks. Types of surveys include visual inspection for signs of dead vegetation near the pipeline and instrument surveys used to detect the presence of gas.

Buildings

All buildings intended for human occupancy within 220 yards on either side of the pipeline will be located and plotted upon company map records as required by DOT. This information will be used to determine the location class, which then is used as a criterion for selecting frequencies of various inspection procedures, designing new pipeline facilities, and upgrading existing facilities.

Equipment Maintenance and Repair

A maintenance program is used by the Applicants for the existing pipeline. This program will be expanded to include the proposed pipeline.

Pipeline Repairs

Repairs required because of minor corrosion and slight external mechanical damage to pipe and coating material are considered to be routine types of repairs. They can be corrected without interruption or with minimum interruption of service. Repairs will be made under a reduced pipeline pressure and would require a minimum amount of excavation and heavy equipment.

Pipeline failures needing major repairs may require shutdown of the pipeline. In these instances, the pipeline segment will be isolated between

mainline valves and the natural gas in the segment needing repair vented to the atmosphere.

Extensive pipeline damage caused by geologic events, such as landslides or earthquakes, require immediate repairs. When conditions prevent these repairs, temporary installations will be required to minimize line shutdown time. Permanent repair will then be implemented when conditions causing the disaster or resulting from the disaster can be corrected. These types of repairs may require extensive manpower, materials, equipment, and a considerable amount of earth movement and excavation. To facilitate these repairs, equipment, pretested pipe, and other repair materials for emergency use will be stored at existing compressor stations and maintenance bases located along the pipeline. In addition, pretested pipe is currently stockpiled at two storage sites near critical locations not accessible by heavy trucks during times of adverse weather. These two sites are located in 30-Mile Canyon (east of John Day River) and Pine Canyon (west of the John Day River). Sections of pipe and other repair materials for the proposed pipeline will also be stored at existing locations. Land acquisitions to expand existing storage sites will not be necessary. No new storage sites are anticipated.

Repairs to Right-of-Way and Access Roads

Other minor repairs include repairs to erosion damage, repairs to erosion checks, replacement of pipeline markers and removal of debris from the right-of-way. These repairs might be made with a grader, other types of earthmoving equipment, or hand tools.

Problems with wind erosion have been experienced by PGT in certain areas of sandy soil, including a section in Wallula District (M.P. 264 to 283) in Oregon. On occasion, wind has uncovered short sections of pipe. Corrective measures, such as snow fencing and straw bales, have been employed with limited success.

It is also anticipated that some settling of the backfilled trench containing the new pipeline will occur, particularly after the first winter following construction. In this case, subsidence and potholes will be filled and the surface restored to normal grade.

The only roads that are maintained are those for access to critical facilities, such as mainline valves, pressure limiting stations and compressor stations. These stations must be visited frequently, requiring the roads to be maintained at all times.

Compressor Stations

Most of the maintenance and repair performed on station facilities is done inside compressor buildings, control buildings, and auxiliary equipment structures. The repair of underground piping will require some excavation in the station yard.

Building and Site Maintenance

Repair and maintenance involving buildings and site facilities will be done as needed. Repairing and painting buildings, aboveground piping, miscellaneous structures, and fences will be accomplished as required.

Emergency Features and Procedures

Design Features for Geological, Meteorological, and Man-Induced Hazards

A general geotechnical investigation of suspected geological hazard areas will be required. Subsequent construction design will include precautionary measures to eliminate or minimize such hazards.

Design and construction criteria will be incorporated in the final design of the system to enhance its ability to withstand possible natural catastrophes and man-caused accidents.

Contouring, terracing, and revegetation of lands subject to erosion will be done during the final cleanup and restoration phase of each construction spread. Also, during routine surveillance of the right-of-way any areas requiring additional erosion control will be identified; corrective measures will then be taken. All pipe placed at crossings of streams and rivers will be laid below scour depth, and weights will be used to prevent flotation. Stream and river banks at crossings will be covered with vegetation, riprap or other protective material to prevent erosion.

The pipeline will be marked at all road, river, and railroad crossings and other specified intervals alerting people to the buried high-pressure gas pipeline.

Buildings containing gas transmission facilities will be equipped with gas detectors with appropriate lights and alarms to alert personnel to hazardous conditions and the procedure specified in the emergency plan will be followed.

Facilities will be monitored and operated under remote control through a communications link with the two control centers. Compressor stations will be equipped with safety devices to prevent overpressuring natural gas in the pipeline. Additionally, the compressor stations will be provided with safety devices which will shut down the pipeline and isolate the station upon detection of fire or presence of explosive mixtures of gas. Also these safety devices will shut down the equipment in the event of a mechanical failure that would endanger the integrity of the equipment and result in consequential hazards. Block valves at compressor stations will be automatically remote controlled and power operated to isolate the stations in case of system failure.

Shutdown and Venting

The detailed steps required to purge a line, part of a line, or part of a compressor station will be included in the operation and maintenance manual. These steps will be strictly adhered to when putting any system or part of a system into service or taking it out of service. The operating and maintenance manual will cover the operations of compressor stations and will incorporate instruction manuals for the equipment.

The compressor station section of the manual will include such items as (1) prestart checklist, (2) start sequence, (3) shutdown instructions for both normal and emergency conditions, (4) pressure relief devices, (5) any other operational or emergency procedures applicable, and (6) operation and testing procedure for the fire protection system.

Emergency Contingency Procedures

An emergency plan outlining all the steps to be taken in the event of system malfunctions or other emergencies will be incorporated in the operations and maintenance manual. Immediately upon the occurrence of a malfunction or failure, that part, piece of equipment, or section of line will be isolated, if necessary. Appropriate action will give priority to the protection of lives and property, permanent repairs and returning the pipeline to service. Maps, diagrams, and records will be maintained to assure that the operating personnel can immediately determine how isolation may be effected for any part or parts of the system.

1.1.4.8 Future Plans

Abandonment of Facilities

Salvage and Disposal of Equipment

The Applicants have no plans to abandon any existing or proposed facilities. Should the pipeline be abandoned; the Applicants indicate the pipe would probably be removed and salvaged. Compressor stations and related facilities would also be dismantled and salvaged. Concrete and pavement could be broken up and disposed of in an approved disposal area or left in place. Pipe installed in rivers, creeks, and lakes would probably be abandoned in place.

Site Restoration

Should the pipeline be removed or abandoned, the Applicants state that the right-of-way and facility sites could be treated with rehabilitation measures similar to those used after construction. However, removal and salvage of the pipeline facilities will create many of the environmental impacts caused during construction.

Future Expansion

The Applicants state that a third line might be installed in the existing right-of-way at some future date.

The need for a third line, its size, construction techniques, materials, etc., are indefinite. A decision to construct a third line would depend on the availability of gas, new technology, and the natural gas markets in California. No plans have been made for construction of any such facilities.

Loops and Laterals

The installation of loops and laterals will depend upon the Applicant's final design and upon Federal and State permits. Under certain circumstances, a third pipeline could be operated independently of any existing pipelines.

Additions to Processing, Treatment, and Measuring Facilities

Should a third line be installed, additional metering, compressors, and related facilities would be needed.

New Plants, Compressor Stations, and Related Facilities

The Applicants have not identified any plans for future construction beyond the proposed 2,180 MMcf/d design capacity of the proposed facility.

1.1.4.9 Actions Involved

Federal

Numerous Federal authorizations will be required prior to construction and operation of the proposed pipeline.

These include:

1) Certificates and Licenses by the Federal Power Commission--Certificate of Public Convenience and Necessity authorizing the construction and operation of facilities and the transportation of natural gas in interstate commerce from the northern border of Idaho to the Oregon/California border. These Certificates are issued pursuant to section 7(c) of the Natural Gas Act.

2) Right-of-Way permits by the Department of Interior--Public Law 93-153, Title I, section 28 parts (a) and (e) provide for the issuance of both long- and short-term permits for pipelines and related facilities for all Federal agencies. Federal agencies administering land along the pipeline route and subject to P.L. 93-153 are U.S. Forest Service, Bureau of Land Management, and Corps of Engineers.

3) Permits

Long-term or permanent use and right-of-way permits will be needed for the pipeline, valve sites, and compressor stations. Short-term permits will be needed for the construction work areas, storage areas and mineral material sales.

4) Other Approvals as Necessary

- U.S. Bureau of Reclamation--Permits for crossing 28 drainage canals.

- U.S. Environmental Protection Agency--Permits for discharge of test water and pollutants.

- U.S. Corps of Engineers--Permits to cross navigable water bodies as follows:

1 crossing of the Snake River

2 crossings of the Sacramento River

1 crossing of the San Joaquin River

State and County

State and other agencies which will be involved in project approval are listed below:

1) California Public Utilities Commission (Issuance of a Certificate of Public Convenience and Necessity)

2) Other approvals as necessary

- Other State Utility Commissions

- State and County Highway and Road Departments

- State Fish and Game Departments

- State Departments of Natural Resources, Water Resources, Environmental and/or land Commissioners depending on State organization and responsibilities.

- County Planning Commissions, Boards of Adjustments, or other local land use control authorities. These vary among states and among counties within each state.

References

The Alberta-California Pipeline System Environmental Report; Published by Pacific Gas Transmission Company and Pacific Gas & Electric Company, San Francisco, California.

The Alberta-California Pipeline System Environmental Report Graphic Supplement; Published by Pacific Gas Transmission Company and Pacific Gas & Electric Company, San Francisco, California.

Responses by Pacific Gas Transmission Company to Questions and Requests for Additional Information Propounded by the Department of the Interior to United States of America and the Federal Power Commission on November 22, 1974; Docket Number CP74-241; December 17, 1974 and January 6, 30, 1975.

Application for a Certificate of Public Convenience and Necessity Pursuant to Section 7(a) of the National Gas Act, as Amended; to United States of America before the Federal Power Commission; Pacific Gas Transmission Company, Docket No. CP74-241.

Application for a Presidential Permit Authorizing the Construction, Operation, Maintenance and Connection of Facilities at the International Boundary Between the United States of America and Canada before the Federal Power Commission, Pacific Gas Transmission Company, Docket No. CP74-242.

Consolidated Application of Pacific Gas Transmission Company and Pacific Gas & Electric Company for Right-of-Way Permits; to United States of America before the Department of the Interior; Pacific Gas Transmission Company and Pacific Gas & Electric Company, December 13, 1974.

Supplement to Amended Application for a Certificate of Public Convenience and Necessity pursuant to Section 7(c) of the Natural Gas Act: to United States of America before the Federal Power Commission: Pacific Gas Transmission Company. Docket No. CP74-241. July 11, 1975.

Application before the Public Utilities Commission of the State of California; Pacific Gas and Electric Company; Application No. 55661; filed May 1, 1975.

2.1.4 San Francisco Pipeline

2.1.4.1 Climate

The climate of the proposed pipeline route ranges from cold winters and hot summers in the north to more moderate winters and summers in the south. Precipitation is generally sparse, and drought conditions occur in the summer in the southern-most portion of the pipeline route.

The climate is generally influenced by the eastern flow of marine air from the Pacific Ocean and is directly influenced by the Rocky Mountains, Cascade, and Sierra Nevada ranges. These ranges are situated transverse to the prevailing westerly air flow, and therefore affect temperature, precipitation, and wind patterns.

Temperature

Seven weather stations were selected as being representative of typical temperature ranges and precipitation amounts along the proposed route. Figure 2.1.4.1-1 and Table 2.1.4.1-1 show average monthly and annual mean temperatures at these stations. Daily temperature ranges of 30° to 40°F occur in all seasons of the year. Maximum temperatures of 90°F or more are common except at higher elevations in Oregon. Along the northern part of the proposed route, average maximum and minimum January temperatures are below freezing. January temperatures in the California segment are about 20°F higher. July minimum and maximum temperatures also differ by about 20°F from the northern to southern segments. Table 2.1.4.1-2 shows temperature extremes and length of frost free periods.

Extreme temperature conditions rarely persist for more than a few days. The length of the frost-free period, an indication of the length of the plant growing season, ranges from as little as 90 days in the northern segment to more than 300 days in the southern segment.

Precipitation

Precipitation varies widely with season, elevation, and location. Annual precipitation is heaviest in the northern part of the proposed route, and decreases southward to Klamath Falls, Oregon. It then increases markedly at Red Bluff, Calif., and from there decreases southward towards Sacramento. Figure 2.1.4.1-2 and Table 2.1.4.1-3 show precipitation means and extremes.

Snowfall also is heaviest, in excess of 70 inches annually, in the northern sections of the proposed route. Elevation and moisture content of the air affects the distribution and amount of snowfall; the heaviest snowfalls occur at high elevations on the windward side of the mountains near the Columbia River.

In some months, there is no recorded precipitation along much of the pipeline route. Table 2.1.4.1-4 shows maximum precipitation.

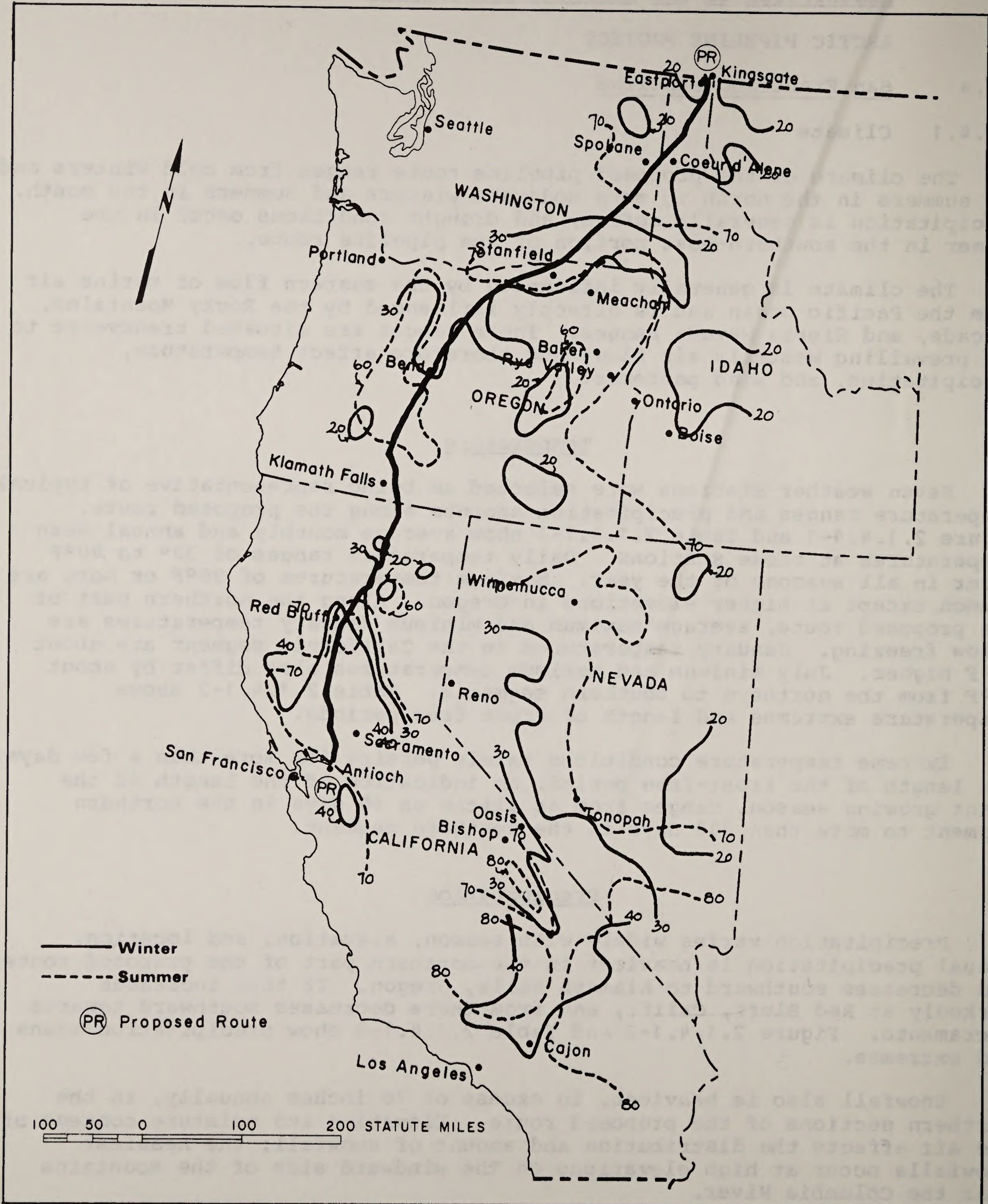


Figure 2.1.4.1-1 Average winter and summer temperatures along the pipeline route

Table 2.1.4.1-1 Average monthly and annual mean temperatures (° F) at selected locations.

LOCATION	Elevation (in feet)	JAN.	FEB.	MAR.	APR.	MAY.	JUN.	JUL.	AUG.	SEPT.	OCT.	NOV.	DEC.	ANNUAL MEAN
Sandpoint, Idaho	2100	26	31	36	45	53	59	65	64	56	46	35	29	46
Spokane, Washington	2357	25	30	38	47	56	62	70	68	61	49	36	30	48
Walla Walla, Washington	949	33	38	47	54	61	67	76	74	66	55	42	38	54
Condon, Oregon	2844	29	33	40	46	53	58	66	65	59	49	38	33	48
Klamath Falls, Oregon	4085	29	34	40	47	54	60	69	67	61	50	39	32	48
Red Bluff, California	342	46	50	54	60	68	76	84	81	76	66	54	47	63
Sacramento, California	17	45	49	53	58	64	70	75	74	72	64	53	46	60

Source: U.S. Department of Commerce,
National Oceanic and Atmospheric Administration (NOAA)

Table 2.1.4.1-2 Weather extremes and frost free periods.

LOCATION	RECORDED HIGHEST/YEAR	RECORDED LOWEST/YEAR	FREEZE FREE DAYS (GROWING SEASON)
Sandpoint, Idaho	104 July 1923	-31 Jan. 1950	121
Spokane, Washington	108 Aug. 1961	-25 Dec. 1968	92
Walla Walla, Washington	113 Aug. 1961	-16 Jan. 1957	136
Condon, Oregon	111 July 1928	-25 Dec. 1919	119
Klamath Falls, Oregon	105 July 1911	-24 Jan. 1888	126
Red Bluff, California	114 July 1960	20 Jan. 1968	225
Sacramento, California	115 June 1961	23 Jan. 1963	295

Source: U.S. Department of Commerce,
National Oceanic and Atmospheric Administration (NOAA)

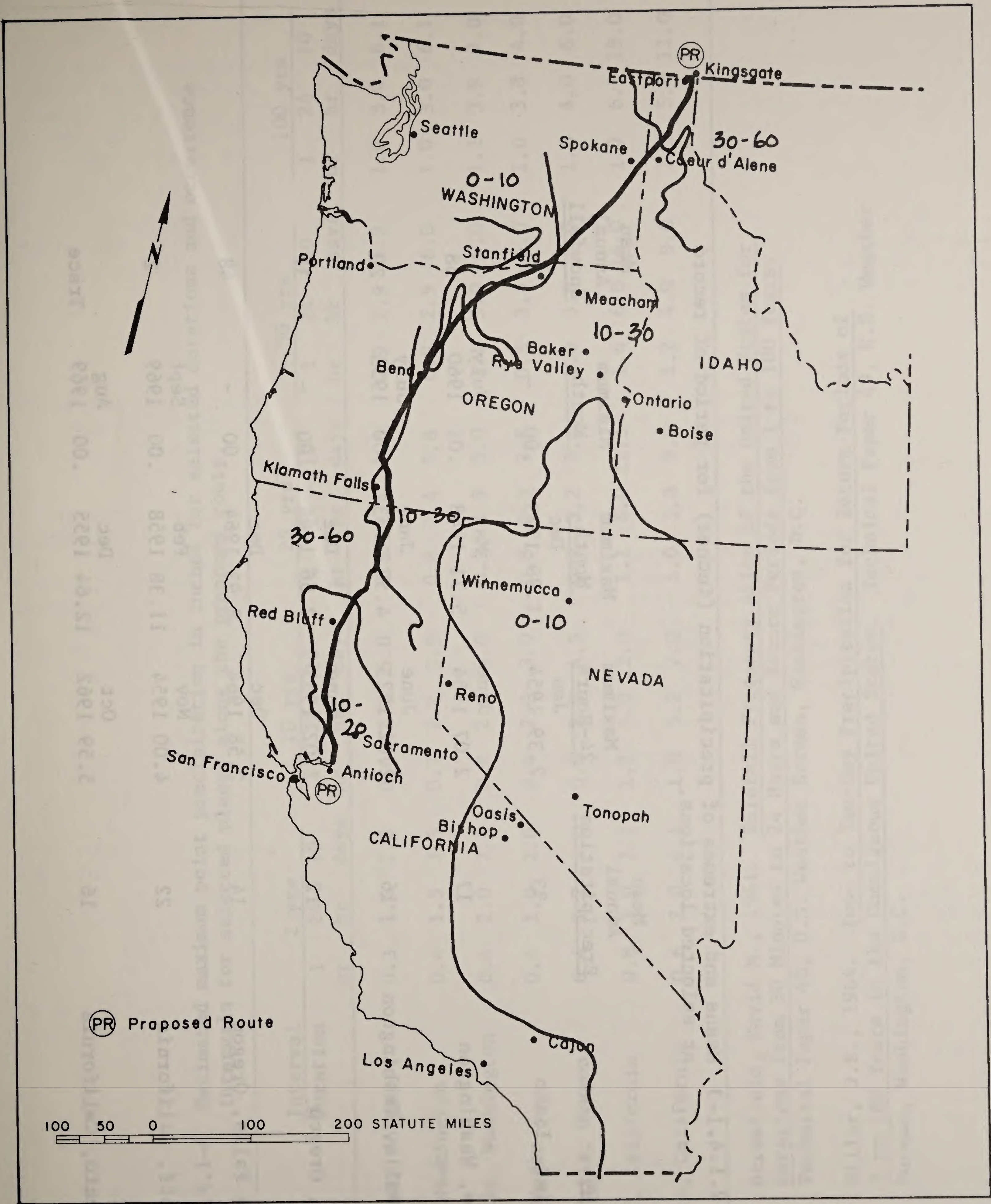


Figure 2.1.4.1-2 Precipitation along the pipeline, in inches

Table 2.1.4.1-3 Means and extremes of precipitation (inches) for period of record at selected locations.

Location	Mean Annual Precipitation	Maximum 24-Hours	Maximum Month	Minimum Month	Mean Annual Snowfall
Sandpoint, Idaho	33	2.39 Jan 1954	11.99 Dec 1973	.00 -	73
Spokane, Washington	17	2.07 June 1964	5.71 May 1948	.01 July 1960	58
Walla Walla, Washington	16	2.02 June 1923	4.52 June 1953	.00 July 1953	20
Condon, Oregon	12	2.02 June 1935	7.56 Dec 1964	.00 -	31
Klamath Falls, Oregon	14	2.58 Dec 1964	8.93 Dec 1964	.00 -	48
Red Bluff, California	22	4.00 Nov 1954	11.38 Feb 1958	.00 Sept 1969	2
Sacramento, California	16	5.59 Oct 1962	12.64 Dec 1955	.00 Aug 1969	Trace

Table 2.1.4.1-4 Estimated maximum point precipitation in inches for selected durations and occurrence intervals for selected places along the proposed route.

Interval	2 yrs			10 yrs			25 yrs			50 yrs			100 yrs		
Duration	1 hr	24 hr	10 days	1 hr	24 hr	10 days	1 hr	24 hr	10 days	1 hr	24 hr	10 days	1 hr	24 hr	10 days
Idaho-Canada Border	0.3	1.4	2.8	0.6	2.3	5.0	0.8	2.4	5.5	0.9	2.9	5.8	1.0	3.0	6.1
Spokane, Washington	0.4	1.5	2.5	0.7	2.2	3.9	0.8	2.4	5.8	0.9	2.9	6.0	1.0	3.0	6.1
Walla Walla, Washington	0.4	2.0	2.5	0.8	2.8	4.0	0.9	2.9	5.0	1.1	3.0	6.0	1.2	3.9	7.0
Condon, Oregon	0.4	1.0	2.0	0.6	2.0	3.0	0.8	2.3	3.8	0.8	3.5	6.0	1.0	3.8	4.0
Klamath Falls, Oregon	0.4	1.7	3.0	0.8	2.8	4.5	0.9	3.2	5.5	1.0	3.6	6.0	1.0	4.0	6.0
Red Bluff, California	0.8	3.0	7.5	1.1	5.0	12.0	1.1	6.0	12.5	1.4	6.0	14.0	1.7	6.5	15.0
Sacramento, California	0.6	2.0	4.4	1.0	3.2	7.0	1.0	3.8	8.0	1.2	4.0	9.0	1.5	5.0	11.0

Sources: Hershfield, David M., 1961. Rainfall Frequency Atlas of the United States for Durations from 30 Minutes to 24 Hours and Return Periods from 1 to 100 Years. Technical Paper 40, U.S. Weather Bureau, Washington, D.C.

Miller, J.F., 1964. Two- to Ten-Day Precipitation for Return Periods of 2 to 100 Years in the Contiguous United States. Technical Paper 49, U.S. Weather Bureau, Washington, D.C.

Winds

Mean and maximum hourly wind speeds at selected places along the proposed route are given in Table 2.1.4.1-5. Based on estimates by Thom (1968) one can expect at the Oregon-Nevada boundary wind speeds of 50 mph (miles per hour) every 2 years, 80 mph every 50 years, and about 84 mph in 100 years. Similar speeds can be expected at other places along the pipeline route.

Hot, dry winds descend the lee side of the mountains adjacent to the pipeline route and, depending on the season, promote conditions favorable to forest fires or flooding. Such winds are possible in any mountainous terrain along the proposed route.

Destructive Storms

Thunderstorms occur periodically in the summer months. Occasionally a storm will be accompanied by heavy rainfall causing local flood damage. Hailstorms are infrequent and are mostly along the northern third of the proposed route.

The year 1964 was one of the most severe on record in the northern segment of the route. The floods in December 1964, were the most damaging in history throughout Oregon and in parts of Washington, Idaho, and California. The floods resulted, in part, from a series of storms in late December, but were primarily from the warm torrential rainfall of December 21-23. Melting snow augmented by rain falling on frozen ground caused excessive runoff; as much as 20 inches of rainfall occurred in some areas. Ground thaw during the flood period resulted in severe erosion of the uplands and sediment deposition on flooded stream terraces.

Micrometeorological Conditions

Fog and Icing

During the winter months, moist air at chilling temperatures may cause fog in some areas crossed by the proposed pipeline. From northern Idaho to northern California, inland fogs occur from 5 to 15 days annually. Fog conditions are more frequent along river bottoms. Southward to Antioch, Calif., 10 to 20 days of fog conditions may be expected each year. (See Figure 2.1.4.1-3.)

Along the more humid eastern segments of the proposed route, sleet and ice storms are infrequent, but they may deposit ice layers causing severe damage to trees and man-made facilities.

Mixing Heights and Inversion Layers

The four months having the maximum occurrences of air stagnation periods (lasting four or more days) are May, September, October and November; the most frequent occurrences are in September and October. Figure 2.1.4.1-4 shows the potential distribution of days of forecasted high air pollution. Conditions likely to cause high air pollution potential days are found along much of the proposed route.

Table 2.1.4.1-5 Mean hourly wind speed in miles per hour.

Month	Spokane, Washington	Walla Walla, Washington	Red Bluff, California
January	8.0	5.1	9.0
February	8.8	5.5	9.3
March	9.5	6.2	9.7
April	9.5	6.1	9.5
May	8.4	5.7	9.2
June	8.5	5.5	9.3
July	7.9	5.4	8.0
August	7.8	5.1	7.6
September	7.7	4.7	7.9
October	7.7	4.5	8.4
November	7.9	4.8	8.4
December	8.3	5.2	8.4
Year	8.3	5.3	8.7
Maximum	56 (Oct. 1950)	67 (Nov. 1958)	68 (Oct. 1962)

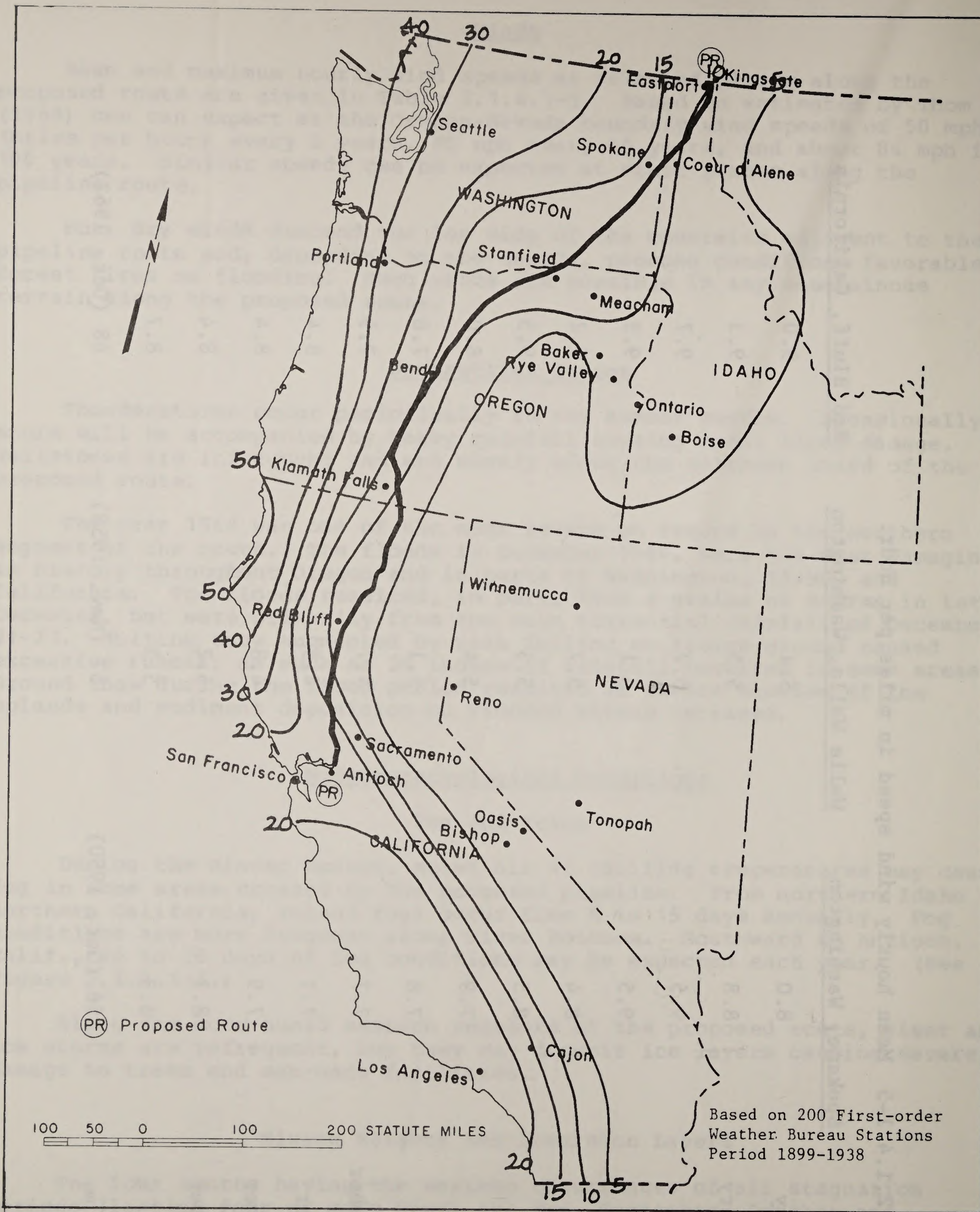


Figure 2.1.4.1-3 Average annual number of days with dense fog

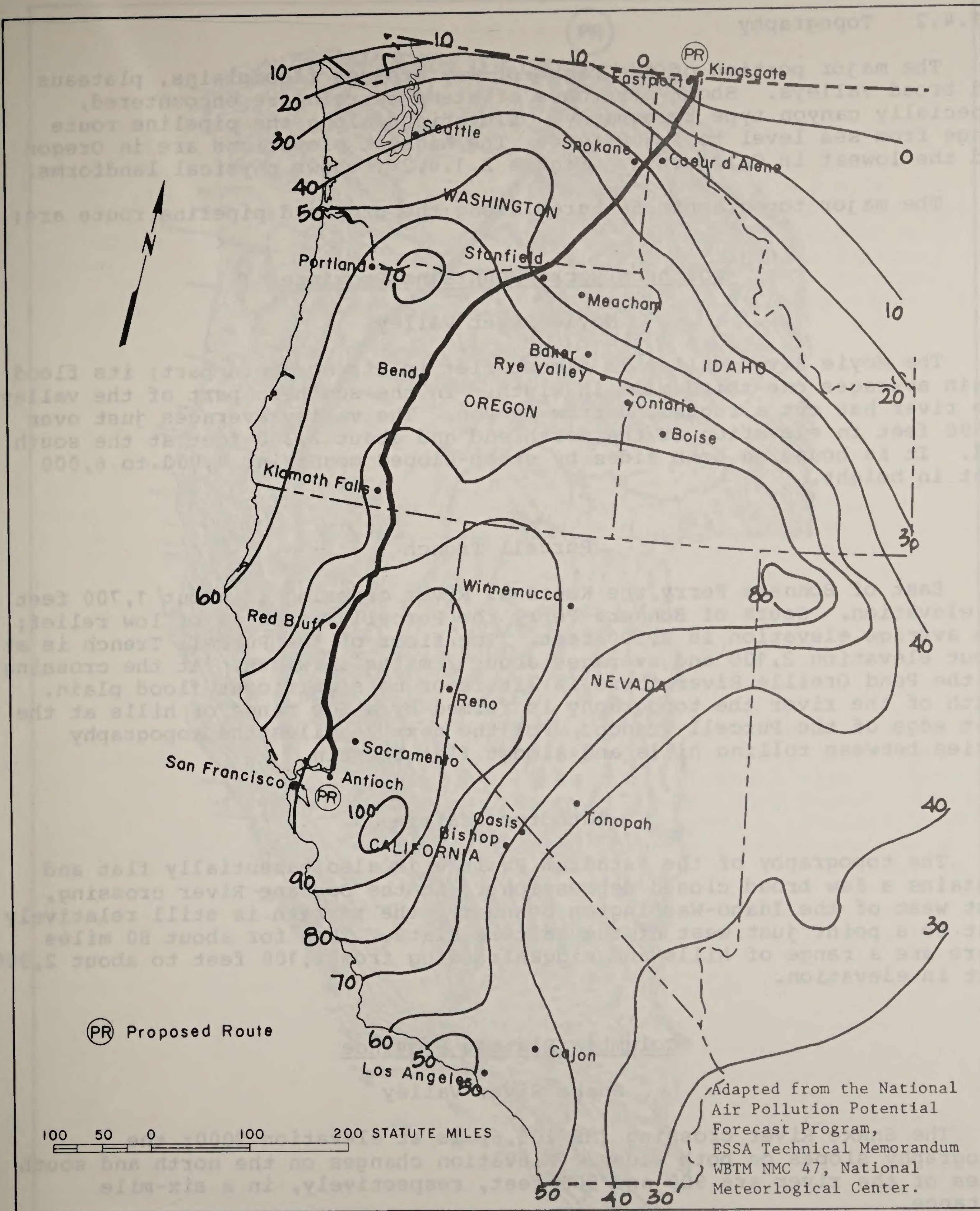


Figure 2.1.4.1-4 Forecast high air pollution potential days

2.1.4.2 Topography

The major portion of the right-of-way crosses floodplains, plateaus, and broad valleys. Short stretches of steep terrain are encountered, especially canyon type topography. Elevations along the pipeline route range from sea level to 5,500 feet. The highest elevations are in Oregon and the lowest in California. Figure 2.1.4.2-1 shows physical landforms.

The major topographic features along the proposed pipeline route are:

<u>Northern Rocky Mountains Province</u>

Moyie River Valley

The Moyie River valley is almost flat in its northern part; its flood plain averages one-third mile in width. In the southern part of the valley, the river has cut a rugged, narrow canyon. The valley averages just over 2,500 feet in elevation at the north end and about 2,300 feet at the south end. It is bound on both sides by steep-sloped mountains 4,000 to 6,000 feet in height.

Purcell Trench

East of Bonners Ferry the Kootenai River crossing is about 1,700 feet in elevation. South of Bonners Ferry the Purcell Trench is of low relief; the average elevation is 2,300 feet. The floor of the Purcell Trench is at about elevation 2,100 and averages about 2 miles in width. At the crossing of the Pend Oreille River there is little or no significant flood plain. South of the river the topography is formed by a low range of hills at the west edge of the Purcell Trench. For the next 25 miles the topography varies between rolling hills and almost flat terrain.

Rathdrum Prairie

The topography of the Rathdrum Prairie is also essentially flat and contains a few broad closed depressions. At the Spokane River crossing, just west of the Idaho-Washington boundary, the terrain is still relatively flat to a point just west of the Saltese Flats. Then for about 80 miles there are a range of hills and ridges ranging from 2,100 feet to about 2,900 feet in elevation.

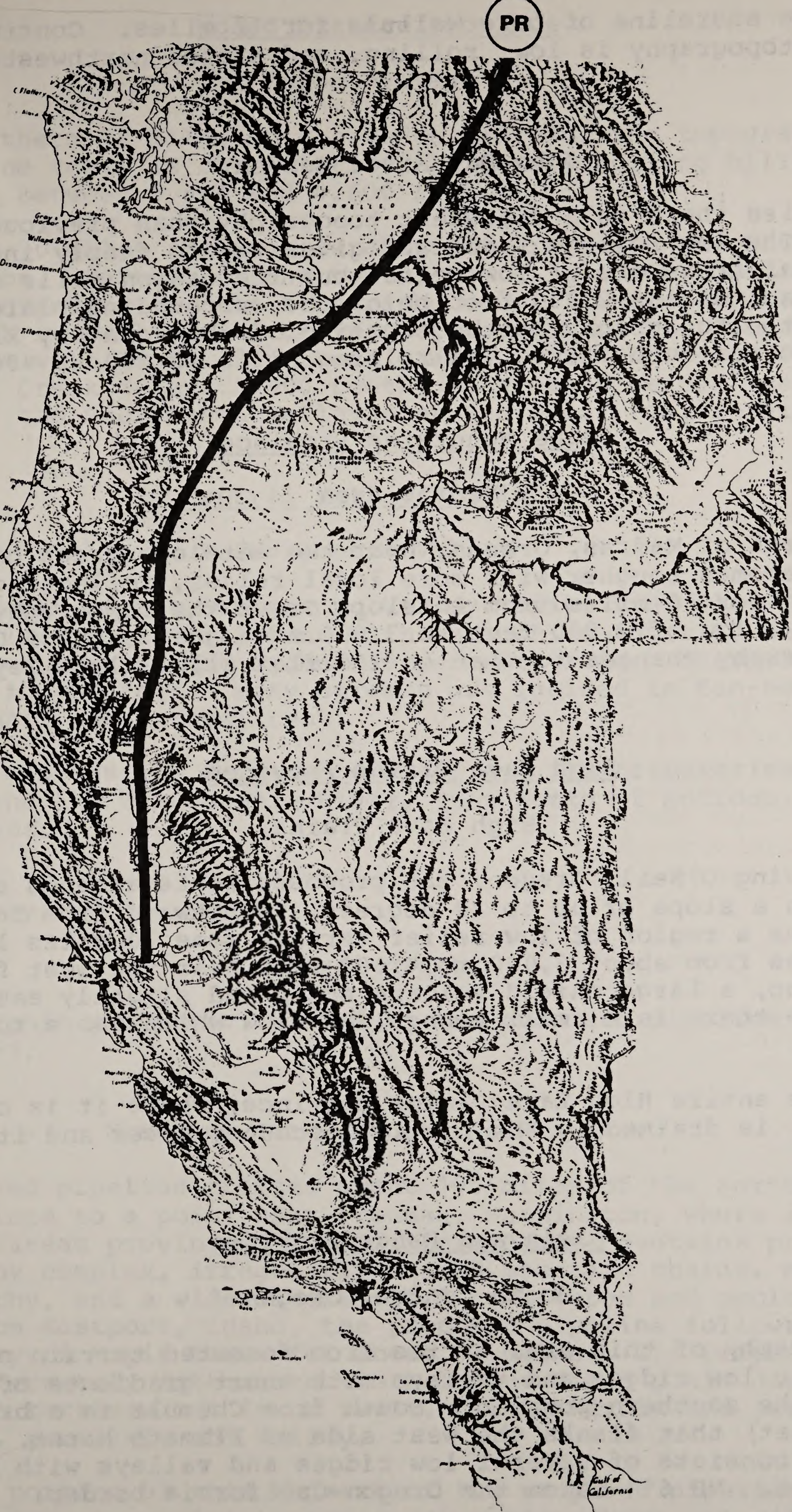
<u>Columbia Plateau Province</u>

Snake River Valley

The Snake River crossing (MP 205.6) is at elevation 2000; the topography slopes on both sides. Elevation changes on the north and south sides of the river are 900 and 500 feet, respectively, in a six-mile distance.

Columbia River Valley

The topography, beginning a short distance beyond the Snake River crossing, becomes a straight southwest-trending flat surface through Eureka Flat, which is some 40 miles in length and averages 3 miles in width. From the Walla Walla River the topography consists mostly of a flood plain,



Source: Raisz, Erwin; Landforms of the United States, 1954.

Figure 2.1.4.2-1 Physical landforms of the western United States

paralleling the shoreline of Lake Wallula for 12 miles. Continuing southwest the topography is low, rolling, and slopes northwesterly for about 50 miles.

John Day River Canyon

For 40 miles there is a different topography than previously encountered. The low rolling landscape gives way to deeply incised canyons. The interfluvial areas are of low relief but the canyon walls are very steep with channels as much as 2,000 feet below the surrounding plains. Such is the nature of the topography at the crossing of the John Day River. Average local relief across much of the low rolling hills is 200 to 400 feet.

Blue Mountains Province

Madras Area

To the north of Madras, Oregon, near the Antelope Creek crossing, the land surface becomes rougher with more local relief, reflecting a different terrain. South for 30 miles from Antelope Creek the topography increases in elevation from a low of 2,000 feet to 3,000 feet just east of Gray Butte. Then the topography changes to that in the flat alluvial valley of the Crooked River.

High Lava Plains Province

High Lava Plains

After leaving O'Neil, Oregon, the proposed route ascends a 100-foot-high bluff with a slope of up to 20 degrees. Southward from this bluff the topography forms a region of low relief terrain some 30 miles long. The elevation ranges from about 3,000 to 4,600 feet near the west flank of Newberry Volcano, a large shield volcano south and slightly east of Bend. Near Lava Butte there is a small young lava flow which has a rough irregular blocky surface.

Almost the entire High Lava Plains province, where it is crossed by the proposed route, is drained by the Little Deschutes River and its tributaries.

Basin and Range Province

South Central Oregon

The topography of this area varies from forested terrain of low relief in the north, to low ridges and valleys with short gradients of as much as 20 degrees in the southern portion. South from Chemult is a broad prairie (elev. 4,600 feet) that flanks the west side of Klamath Marsh. Thereafter, the topography consists of several low ridges and valleys with relief of as much as 500 feet. MP 611 is on the Oregon-California border.

Modoc Plateau Province

Modoc Plateau

In the northern 70 miles of the Modoc Plateau, the topography along the proposed pipeline route is characterized by gently rolling hills. Elevations vary between 3,400 and 4,600 feet.

The second 70 miles are considerably more rugged. The Pit River is in a 900 foot canyon. Farther to the south, there is a 500 foot canyon (Old Cow Creek). Continuing on, the topography consists of moderately rugged terrain in which several creeks drain westward toward the Sacramento Valley. There are slopes with 30 to 35 percent grades. The 800 foot deep canyon of North Fork Bear Creek (elev. 1,900 feet), is crossed before the route drops to the floor of the Sacramento Valley near Red Bluff, California.

Central Valley Province

Sacramento Valley

The topography of the Sacramento Valley varies from flat lands to rolling foothills and alluvial fans with as much as 40 or 50 feet of local relief and slopes that do not exceed 10 percent grade. Elevations range from sea level to 400 feet. Many streams are incised in fan-head trenches and most are small and intermittent.

The route crosses the Sacramento River and its tributaries in the northern part and the San Joaquin River, just north of Antioch, at its southern terminus.

2.1.4.3 Geology

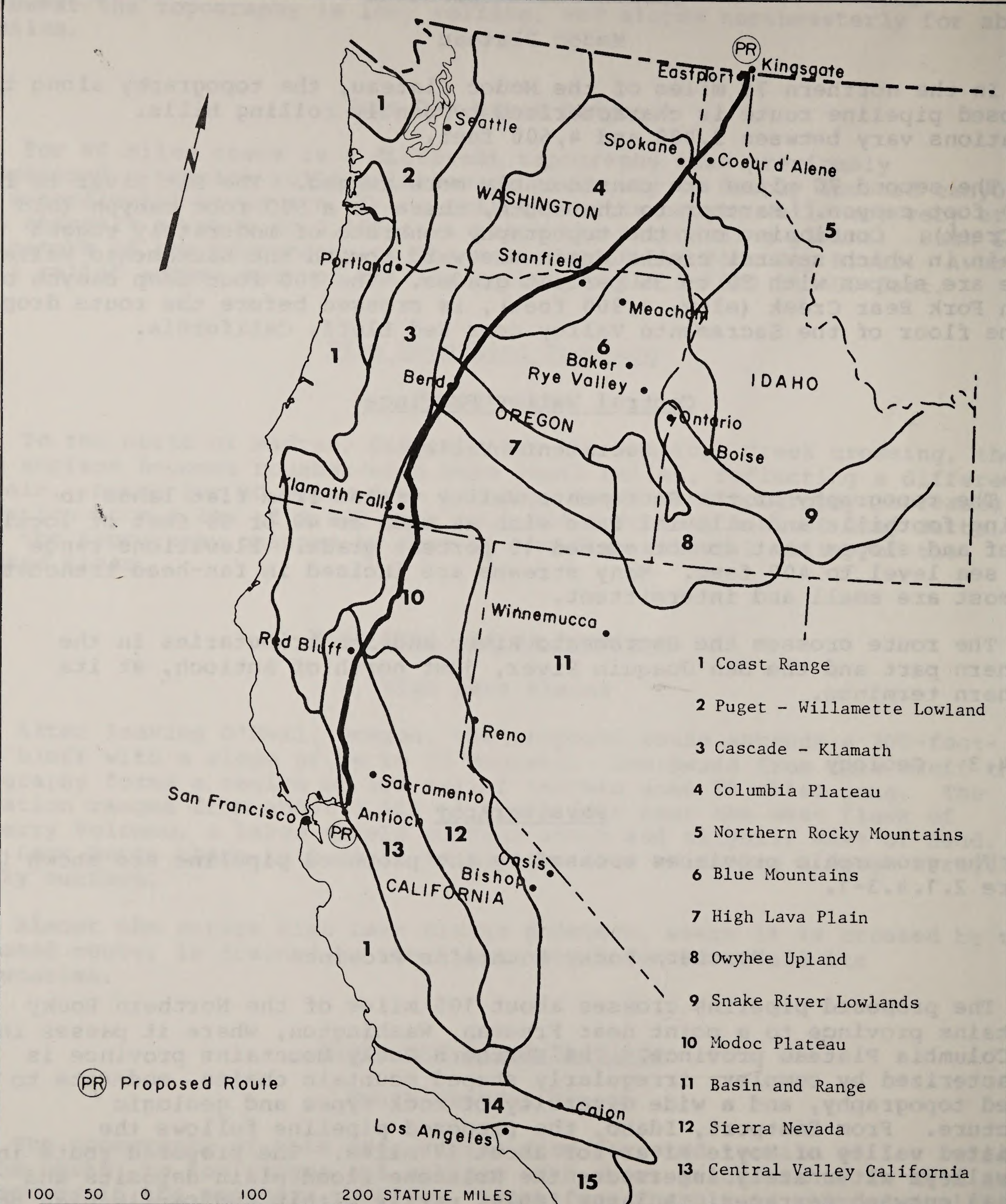
Physiography

The geomorphic provinces crossed by the proposed pipeline are shown in Figure 2.1.4.3-1.

Northern Rocky Mountains Province

The proposed pipeline crosses about 105 miles of the Northern Rocky Mountains province to a point near Freeman, Washington, where it passes into the Columbia Plateau province. The Northern Rocky Mountains province is characterized by complex, irregularly shaped mountain chains, moderate to rugged topography, and a wide diversity of rock types and geologic structure. From Eastport, Idaho, the proposed pipeline follows the glaciated valley of Moyie River for about 17 miles. The proposed route in the valleys alternately intersects the Holocene flood plain deposits and glacial outwash terraces. A large fault, partly within and partly high on the east flank, parallels the valley.

The major portion of this segment of the proposed pipeline lies within the Purcell Trench, a prominent structural valley about 280 miles long, most of which is in Canada. Hummocks and wet closed depressions are common. The portion of the trench traversed by the proposed pipeline ranges from less than 1 mile to about 8 miles in width. North of Pend Oreille Lake the slopes bounding the trench are steep for about 2,000 feet above the valley.



SOURCE: Modified from Hammond, Edwin H., 1965, Physical Subdivisions, in U.S. Geological Survey, The National Atlas of the United States of America, 1970, p. 61

Figure 2.1.4.3-1 Geomorphic provinces

In the United States, the location and configuration of the trench is probably controlled by faults concealed beneath the glacial and alluvial material that floor the trench. None of these faults are known to cut the Pleistocene and younger glacial alluvial sediments.

Only a few faults have been identified in this area, mainly on the basis of aeromagnetic lineaments and the differences in metamorphic grade on either side of Coeur d'Alene Lake. The Coeur d'Alene fault, which is offset by the Rathdrum fault, appears to be the bounding structure of the Purcell Trench in this area. Neither of these faults is known to cut Quaternary deposits. The rolling topography at the southern end of this province is the result of wind and floor water erosion of Pleistocene loess deposits. The loess was almost entirely stripped away during late Pleistocene floods caused by catastrophic draining of glacial Lake Missoula.

Columbia Plateau Province

The Columbia Plateau is a mountainous region that is actually a broad shallow basin. The low point, except for the valley of the Columbia River itself, is situated at Pasco, Wash., near the center of the province, where the Snake and Columbia Rivers join. The basin generally slopes toward Pasco from the edge of the plateau and reflects the structure of the bedrock. In northern Oregon, the plateau and its underlying bedrock slope northward, toward the Columbia River and away from the Blue Mountains. Locally, the bedrock is folded into long, roughly west to northwest trending, anticlines and synclines, which are expressed as ridges and valleys. The proposed pipeline crosses one such ridge, the Horse Heaven Hills, just south of the Walla Walla River crossing. The rolling topography of southeast Washington is defined by dunelike hills of Pleistocene loess. Along the channeled scablands north of the Snake River, the loess was partly to entirely stripped away during late Pleistocene floods, related to catastrophic draining of glacial lake Missoula.

Most rivers in the province are incised into gently tilted basalt flows. Channels are narrow and bounded by steep valley walls. Except for Walla Walla, Touchet, and part of Grande Ronde Rivers, flood plains are narrow to nonexistent. Large sand and gravel bars, resulting from giant late Pleistocene floods, occur along sections of the Palouse and Snake Rivers. Parts of the route pass through the channeled scablands, a complex network of channels formed during these floods. Some small basins with no natural outlets occur in the scablands. Almost the entire proposed pipeline route encounters modified loess which overlies the Columbia River basalts.

The loess blanket thins towards the southwest and the chance of encountering shallow bedrock basalt becomes greater in that direction.

Blue Mountains Province

The Blue Mountains Province is a geologically diverse, hilly to mountainous area south and southeast of the Columbia Plateau. In general, major ridge crests trend northwest, reflecting control by the complex Blue Mountains anticline. South of the anticline the effect of Basin and Range faulting is seen in the north-northwest trending topography. In the western part of this province much of the topography shows a north to northeast trending grain, possibly reflecting old faults. Constructional landforms created by Pliocene and Pleistocene volcanism occur in the extreme western part, especially in the vicinity of the pipeline crossing. Landsliding is common in the Blue Mountain province where heavy basalt flows overlie

incompetent tilted altered tuffaceous and rocks of early and middle Tertiary age. The proposed route crosses 40 miles of this province.

High Lava Plains Province

The proposed route enters the western end of the High Lava Plains of eastern Oregon at the Crooked River and continues southward, leaving the province south of La Pine a distance of only 50 miles. The region generally has lesser relief than areas to the north and south but lies at high elevation (typically 3,000 to 5,000 feet). It contains a few isolated high mountains, such as, Newberry Volcano whose west flank is traversed by the proposed pipeline. The province is formed of late Cenozoic volcanic rocks which locally contain interbedded fluviatile and lacustrine sedimentary rocks. These are offset by northwest trending faults of the Brothers Fault Zone. The physiography is of constructional volcanic origin.

Basin and Range Province

From La Pine, Oregon to the crossing of the Williamson River, about 63 miles, the proposed pipeline lies along the border between the Basin and Range province on the east and the Cascade Range province on the west. South of the Williamson River to the Oregon-California border it lies entirely within the Basin and Range province. This part of the Basin and Range province is underlain by upper Cenozoic volcanic and sedimentary rocks that are offset by northerly trending large faults with considerable dip-slip movement. The consequent terrain is one of high ridges separated by either steep high escarpments or gentle slopes from adjacent valleys. Elevations in the region range from 4,000 to over 8,000 feet. The proposed pipeline route is mostly below 5,000 feet and remains for the most part along the flat floored valley bottoms, the lowest possible relief of the province.

Modoc Plateau Province

In the Modoc Plateau, as far as 20 miles south of the Pit River, the route is mostly on faulted constructional volcanic topography that is slightly affected by erosion, except for the Pit River Canyon. Hills and mountains in this region are nearly all volcanoes or fault blocks. The southern portion of the proposed route, from Old Cow Creek south, is a dissected dip slope in which canyons are followed by streams flowing westward down the regional dip.

For the first few miles south of Oregon, the proposed route follows west facing fault scarps that border the basin of ancestral Tule Lake. Thereafter it traverses lava plains, several cinder cones, and the flank of the Medicine Lake Highlands, a large shield volcano. Indian Springs Mountain, which the proposed route skirts 50 miles south of Oregon, is part of the Big Valley Mountains fault block that has young lavas around it. Other fault blocks are found around Lake Britton and Burney. South of Burney the proposed route flanks Burney Mountain volcano, and shortly thereafter crosses southwestward out of the fault block terrain and down the dissected dip slope drained by Cow Creek, Bear Creek, and other creeks. This slope is characterized by canyons that cut down into older rocks. Some uneroded lava flows and cinder cones are also present. The route descends the dip slope westward past the small Black Butte cinder cone to the flat floor of the Sacramento Valley.

Sacramento Valley Province

The proposed pipeline enters the Sacramento Valley proper near Red Bluff, California defined by Bryan (1923) as the geomorphic border of the Sacramento Valley province. The Sacramento Valley is actually the northern part of the Central or Great Valley of California. Only the western side, along which the pipeline route is proposed, will be considered in this discussion.

Shortly after entering the province, the proposed pipeline route crosses the floodplain and modern channel of the Sacramento River. Here the floodplain is approximately 12,000 feet wide and the modern channel only a few hundred feet in width. The western tributaries of the Sacramento River, many of which are crossed by the proposed pipeline, are not large in comparison with the Sacramento itself. From north to south: Stony, Cache, and Putah creeks are the only sizable creeks between Red Bluff (the second crossing of the Sacramento River) and the first crossing of the San Joaquin River near the termination of the proposed pipeline route. The valley floor slopes southward from an altitude of about 300 feet to near sea level at the Antioch terminal. Low alluvial plains and fans form a belt along the western Sacramento Valley from Corning, south of the Montezuma Hills, a distance of about 125 miles. At the extreme northern end of the Valley, the low plain and fans lie between dissected uplands and low hills underlain by the Red Bluff Formation. Southward, the proposed pipeline route encounters the broad eastward and southeastward sloping alluvial fan built by the braided stream channels of Stony Creek. Stony Creek's fan head is 5 miles northwest of Orland, while its southern limit is near Willows. This fan is about 15 miles wide and 20 miles long with an average southeasterly slope of about 12-1/2 feet/mile. The fan surface is not smooth but cut by incised channels 1 to 5 feet deep, most of which lie south of the presently active Stony Creek channel entering the Sacramento River near the City of Hamilton.

South of the Stony Creek fan, the belt of low plains narrows to an average width of less than 10 miles. The eastward flowing streams crossing this area are small and intermittent with small, poorly defined alluvial fans.

From Williams south to Cache Creek the proposed route lies between the northwestward trending Dunnigan and Rumsey Hills and the Colusa Basin. The proposed route runs through these hills, the lowest foothills of the Vaca Mountains, which are the easternmost part of the Northern California Coast Ranges. These hills are the result of erosion of late Tertiary and Quaternary rocks all dipping in the same direction on the east flank of the Coast Range uplift. The Rumsey Hills are composed of a tilted fault block of upper Cretaceous and upper Tertiary rocks. The Dunnigan Hills resulted from anticlinal uplift that affects Pliocene and Quaternary rocks at the surface. Many slopes are relatively steep along this part of the proposed route, as much as 50 feet per mile. South of the Cache Creek crossing, the Dunnigan Hills give way to a group of low disconnected hills known as Plainfield Ridge. The proposed pipeline route lies west of this ridge at the base of the low hills north of Winters. These hills are composed of dissected Tehama Formation. Slopes steepen somewhat along the proposed route, averaging about 16 feet per mile.

From Putah Creek to the north edge of the Montezuma Hills, the slope of the low plains changes from east to southeast. Many small channels and levees cross this plain making their way toward the Yolo Basin. Most channels are incised 2 to 10 feet into their channel levees, but Putah Creek is incised as much as 40 feet into its present levee ridge. Much of this downcutting may be due to human changes in stream courses as well as

reclamation projects in the large flood basins such as the Yolo. From Winters, southeast, the alluvial plain slopes at about 6 feet per mile.

West of Rio Vista and north of the mouth of the Sacramento River the Montezuma Hills form an isolated, roughly circular area 10 miles across underlain by continental gravels. Maximum elevation is about 260 feet dropping to sea level on the south side of the hills.

Bedrock Stratigraphy and(or) Lithology

Northern Rocky Mountains Province

About 122 miles of the proposed pipeline lie within the Northern Rocky Mountains physiographic province: about 12 percent crosses the Precambrian Belt Supergroup, 1 percent metamorphosed Belt Supergroup(?), 11 percent Cretaceous and Tertiary granitic (plutonic) rocks, less than 1 percent Cretaceous Sandpoint Conglomerate, 4 percent Quaternary Palouse Formation, and 72 percent Quaternary glacial-alluvial sediments (see Figures 2.1.4.3-2 and 2.1.4.3-3).

About midway between Sandpoint and Elmira the proposed route crosses a single hill of east dipping Sandpoint conglomerate, the youngest pre-Quaternary unit encountered by the route in the Northern Rocky Mountains physiographic province. Measured dips average about 25 degrees. The formation is predominantly well indurated, poorly bedded boulder to pebble conglomerate, and is exposed only in the Purcell Trench. If the proposed pipeline crosses relatively unweathered outcrops of this unit, some trenching difficulties could be encountered.

Cretaceous plutonic rock is crossed by the proposed route just southwest of Bonners Ferry, Idaho, and at various places in and on the flanks of the Purcell Trench. On the east side of the Purcell Trench, nonfoliated, relatively unweathered hornblende-biotite granodiorite is the most common plutonic type. In and west of the trench highly foliate, deeply weathered, muscovite-biotite quartz monzonite is most common. Most of the plutonic rock traversed is weathered, although erosional knockers and some areas where the glacier has removed the heavily weathered rock, could necessitate extensive blasting.

The proposed pipeline crosses the Belt Supergroup at several places; between Eastport and Bonners Ferry, between Cocolalla and Pend Oreille Lakes, and in the low mountains southwest of Spokane. The Belt Supergroup along this strip consists almost entirely of the Prichard Formation, the oldest unit in the Belt in this region, and Precambrian diorite sills (a hard, dark plutonic rock) that intrude the Belt. The Prichard Formation is made up of interbedded argillite, siltite, and quartzite (recrystallized claystone, siltstone, and sandstone respectively). In and west of the Moyie River valley, areas may be encountered where trenching will be difficult. The quartzite and diorite in this formation are hard, tough rocks that will require blasting if surficial deposits are thin. Along most of the right-of-way where the Belt rocks are traversed a fairly deep cover of soil is expected.

On the south side of the Spokane Valley to the point where the proposed pipeline leaves the Northern Rocky Mountains province, the right-of-way crosses several small areas of crystalline rock that were probably derived from metamorphism of the Belt Supergroup. Although these rocks have been highly recrystallized, weathering is fairly deep in most places and trenching should be easy. Schist, gneiss, and locally quartzite layers make up this unit. Nowhere along this part of the route do steepness of slope,

lithology, and development of foliation appear to combine to present a landslide hazard.

Columbia Plateau Province

Except for a few isolated outcrops of Precambrian sedimentary rocks south of Spokane, the bedrock of the Columbia Plateau province is mid-Miocene Yakima Basalt, the major formation in the Columbia River Basalt Group (see Figures 2.1.4.3-3 to 2.1.4.3-6). The thickness of the basalt ranges from hundreds to thousands of feet and occurs in flows from 10 to more than 100 feet thick, averaging about 50 feet. Each flow has a scoriaceous upper zone a few feet thick and is thoroughly jointed due to contraction during cooling. This jointing greatly aids in excavation. Borrow pits in the basalt are common. Tuffs or sedimentary rocks of non-volcanic origin, generally less than 1 foot thick along the proposed pipeline route, lie between some flows. Some flows have basal units of pillows and clastic debris, which formed as the flow advanced across a ponded river or lake. Within 40 miles of Spokane, the upper flow along the proposed route commonly has such a basal unit which is readily excavated.

The basalt crops out discontinuously. It occurs at the ground surface along major drainages, in the scabland, and in places such as northern Oregon, where wind has stripped away the overlying loess. The depth to the bedrock is 100 or more feet in the Waitsburg, Walla Walla, and Eureka Flat areas, but generally is less than 100 feet. In northern Oregon it is commonly a few feet below the surface. Except for the Horse Heaven Hills, the basalt in the area of the proposed pipeline is gently warped, at most 2 to 3 degrees but generally much less.

Blue Mountains Province

The Columbia River Basalt, chiefly or exclusively Yakima Basalt, forms a minor amount of the Bedrock in the northern part of the Blue Mountains province where it is crossed by the proposed pipeline (see Figure 2.1.4.3-6). The characteristics of the basalt are similar to those in the Columbia Plateau province. In the Blue Mountains province, the basalt is uplifted along the Blue Mountains anticline and faulted in the La Grande area about 60 miles east of the proposed route. Maximum dips, except locally along faults, are less than 8 to 10 degrees.

The chief bedrock unit crossed in the Blue Mountains province is the John Day Formation of Oligocene and early Miocene age. The John Day Formation in this area consists mainly of primary and reworked airfall tuffs, with lesser amounts of ashflow tuff (some welded), basaltic lava flows, and rhyolite domes. The formation is deformed along north-northeast trending faults and folds, and dips greater than 10 degrees are common. The tuffs, originally of rhyolitic to dacitic composition, are largely altered to zeolites and clay minerals, chiefly montmorillonite. These clay minerals swell when wet and become very slippery. The altered tuffs are subject to landsliding, especially where they dip more than 10 degrees, and are overlain by heavy, relatively competent Yakima Basalt.

Other bedrock along this portion of the proposed route consists of volcaniclastic rocks (sedimentary rocks containing volcanic debris) of the Eocene and lower Oligocene Clarno Formation, and unnamed basalt flows of Pliocene and Pleistocene age. The volcaniclastic rocks of the Dalles Formation are river or stream deposits, and made up of conglomerate, sandstone, and siltstone. Their source material ranges in composition from dacite to andesite; most of the material is fairly fresh and unaltered, and

the bedding is essentially horizontal. The Clarno Formation consists of rhyolite domes and andesite flows, tuff, and breccia. The formation is faulted and gently folded. There is little if any surficial cover on any of these bedrock units.

High Lava Plains Province

Where the proposed route enters the High Lava Plains province on the south side of the Crooked River valley, it crosses Quaternary basalt flows derived from the north flank of Newberry Volcano, a 40- to 25-mile shield volcano southeast of Bend (see Figures 2.1.4.3-6 to 2.1.4.3-8). South of the Crooked River the proposed route ascends the gently sloping north and northwest flank of Newberry Volcano on Quaternary basalt flows whose irregular upper surfaces are marked by pressure ridges, tumuli, and collapsed lava tubes (all of these are features that may complicate trenching). East and west of this part of the proposed route, at Powell Butte and Forked Horne Butte, rhyolitic to dacitic domes and associated tuffs and tuffaceous sedimentary rocks of the Oligocene and lower Miocene John Day Formation crop out. Quaternary basalt and andesite flows derived from the Cascade Range and from local vents marked by cinder cones, Pilot, Long and Forked Horn Buttes, crop out west of the proposed route.

Between Bend and Sugar Pine Butte, the proposed route crosses the Northwest Rift Zone of Newberry Volcano and is marked by several young lava flows, numerous cinder cones, and several northwest trending faults. Basalt flows representing the two youngest eruptions occur in a zone that extends southeast from Lava Butte, about 4,000 feet west of the proposed pipeline, to East Lake in the caldera atop Newberry Volcano. Near Lava Butte, the proposed route crosses the southeast flow of the two Gas Line Flows, which are 5,800 C^{14} years old, and similar in age to several other young flows in the Northwest Rift Zone. These Gas Line Flows were mapped after constructions of the existing pipeline and were so named because of their proximity to the pipeline. Eruptions along East Lake Fissure at the southeast end of the zone are younger than 1,970 C^{14} years B.P. An undated flow at Lava Butte may be similarly as young as its surface is considerably less modified than the Gas Line Flows and cinders from Lava Butte mantle the Gas Line Flows.

The Gas Line Flows issued from a northwest trending fissure near the center of the two flows. This fissure parallels a nearby 20-foot fault scarp crossed by the proposed route. Other faults of the Northwest Rift Zone of Newberry are traversed by the proposed route between Bend and Lava Butte (see Geologic Strip Map, Figure 2.1.4.3-6, for this area). Numerous cinder cones of Holocene and latest Pleistocene age on the northwest flank of Newberry Volcano are alined parallel to this fault system.

About 1-1/2 miles south of the crossing of the Gas Line Flows the proposed route passes 500 feet east of Lava River Cave State Park. Lava River Cave, a lava tube that is open to the public and is of high tourist attraction because of its proximity to U.S. Highway 97, extends 1 mile northwest of the collapse-formed opening at the Park. The southeast part of the lava tube, which is closed to the public, probably extends under the proposed route. To the south, the proposed route passes over older (Quaternary) flows on the west flank of Newberry Volcano, many of which end with steep faces near the proposed route. These older flows are forest covered and their surfaces, although locally rough due to tumuli and pressure ridges, are slightly modified by erosion and mantled by ash and loess. About 5 miles southwest of Lava Butte, the proposed route crosses a small cinder cone that is one of a series of cones aligned along a north-northwest trending fissure. Near Paulina Creek the proposed route descends

off the Quaternary basalt flows and enters a broad plain that extends for several miles beyond La Pine. Basalt flows along this section of the proposed route are mantled by Quaternary sediments, ash, and pumice.

As much of the segment south of Bend passes across hard, fresh volcanic rock with little or no surficial material, extensive blasting probably will be required.

From just south of Chemult to the Williamson River, the proposed pipeline traverses a flat area bordering the west side of Klamath Marsh. It is underlain by Mazama airfall ash and slightly younger pumiceous glowing avalanche deposits from the final stages of eruption of Mount Mazama. Crater Lake, which resulted from the collapse of Mount Mazama during these eruptions, lies 10 miles west of the proposed route. The glowing avalanche deposits are as much as 90 feet thick along the proposed route and are formed by unconsolidated, generally unstratified, and poorly sorted lumps of pumice less than an inch to more than 3 feet in diameter and fine to coarse vitric ash, mineral grains, and accidental fragments.

Basin and Range Province

Upon crossing the Williamson River, the proposed route veers southwestward away from the Cascade Range into the Basin and Range province of southeastern Oregon. The proposed route in this region lies entirely on upper Cenozoic volcanic and sedimentary rocks that are offset by numerous north and northwest trending normal faults. Faults intersect the proposed route in a 3-mile segment south of Solomon Butte, two miles southwest of Sprague River, and near Buck Butte. All have displacements less than 200 feet.

Basalt and andesite flows of Pliocene and Pleistocene age that crop out in the northern parts of the region are cut by numerous faults, the largest of which forms Walker Rim, a 1,000 foot-high escarpment about 3 miles east of the proposed route. Faults that parallel Walker Rim obliquely, intersect the proposed route near Crescent and about 10 miles south of Crescent. Walker Mountain, east of the proposed pipeline, is a Pliocene andesitic volcano that is cut by faults of the Walker Rim System. The alined series of Pleistocene cinder cones on Crescent Butte suggests that some of the younger basalt flows in the area were probably locally derived. Many of the basalt and andesite flows traversed between Bend and Chemult are probably issued from numerous vents on the eastern flank of the Cascade Ranges, such as those at Odell, Ringo, and Masten Buttes.

Mazama air-fall ash and pumice form a surface veneer on the basalt and andesite flows, and thickens southward from 5 feet near Bend to over 10 feet south of Walker Mountain. Wind and water erosion has redistributed the 6,600 C^{14} year old ash so that it is now thicker in depressions and locally absent on steeper slopes. None of the basalt flows along the proposed route are younger than the Mazama ash.

South of the Williamson River, the proposed route traverses the southwest flank of Solomon Butte, a 1,100-foot-high Pliocene or lower Pleistocene basaltic volcano, and then continues southeastward over lower Pleistocene or Pliocene basalt flows. Mazama ash which overlies the basalt flows thins abruptly southward from 5 to 10 feet near the Williamson River to less than 6 inches in the Sprague River valley. About midway between Saddle Mountain and Applegate Butte, the proposed route lies on upper Tertiary lacustrine, fluviatile sediments and basaltic fragmental rocks. These deposits underlie much of the proposed route southward to near the Oregon-California border and are probably largely of Pliocene age. They

consist of complexly interbedded lacustrine diatomite and basaltic sandstone and siltstone, intercalated coarse basaltic tuff and breccia, palagonitic tuff of maars and tuff cones, and fluviatile basaltic sandstone and siltstone. Near the town of Sprague River the unit is as much as 800 feet thick. Upper Tertiary basalt flows, breccias, and tuffs are traversed by the proposed route around Buck Butte.

Modoc Plateau Province

No detailed geologic mapping has been done either in the vicinity of the proposed route in California between the Oregon-California border or where the proposed route enters the Central Valley. Most of the area is known as the Modoc Plateau, and has been geologically mapped in reconnaissance only (see Figures 2.1.4.3-8 to 2.1.4.3-12).

Bedrock in the Modoc region consists chiefly of hard volcanic basalt and andesite flows of upper Tertiary and Quaternary ages. Volcanic cinders and minor amounts of volcanic sediments and breccias occur among these locally. The proposed route traverses about 30 miles of Miocene and Pliocene lavas, which especially in the southwest part of the region generally have some soil cover.

Eighty miles of the proposed route is over hard Quaternary lavas, of which 20 percent (15 pipeline miles) are shown as Recent in age on the geologic strip map. The Quaternary lavas generally have little soil cover. Young basalt flows with primary pahoehoe (platy) rock surfaces occur for many miles along the proposed route, for instance; between Tule Lake basin and Timber Mountain, and between Indian Springs Mountain and the Fall River. These flows are sparsely vegetated, have irregular topography, may be difficult to excavate, and are commonly underlain by hidden lava tubes. One of the most extensive lava tube systems ever described is in pahoehoe just northwest of the proposed route between Medicine Lake Highlands and Indian Springs Mountain. Other flows are aa lava, which is surfaced by clinker.

Lacustrine diatomite deposits of Pliocene and possibly Miocene age are exposed for a short distance near and possibly along the proposed route at the shore of Lake Britton, halfway between Oregon and the Sacramento Valley. These rocks are soft, porous, lightweight, relatively impermeable, and commonly break with a conchoidal fracture.

The oldest rocks traversed by the proposed pipeline on the Modoc Plateau are sedimentary rocks of the Cretaceous Chico Formation (marine sandstone) and the Eocene Montgomery Creek Formation (fluvial sandstone and shale). They are exposed for a few miles along the canyon of the North Fork of Bear Creek, a few miles northeast of the Sacramento Valley. The Chico consists of poorly to moderately lithified massive sandstone, with lesser amounts of shale. The Montgomery Creek is sandstone that is less well cemented, interbedded with silty shale and locally with thin beds of low-grade coal. The Montgomery Creek varies from 0 to 750 feet thick. Slumping and landsliding are widespread in this incompetent formation. Big slumps and flowage within the Montgomery Creek area have affected the overlying Tuscan Formation, causing many offsets mappable as faults.

Sacramento Valley Province

The only pre-Quaternary unit exposed in the Sacramento Valley province is the Pliocene-Pleistocene Tehama Formation. As this unit spans the Tertiary-Quaternary boundary, it could be described in either the bedrock or

surficial sections of this report. It will be described in the surficial deposits section.

Surficial Deposits

Northern Rocky Mountain Province

Within the Northern Rocky Mountains physiographic province, about 5 miles of the proposed pipeline crosses the Palouse Formation, and about 88 miles crosses Quaternary glacial-alluvial sediments. The proposed route encounters the Palouse Formation (wind blown glacial silt) at only a few places before the pipeline actually drops onto the Columbia Plateau. Glacial-alluvial material is even more abundant than shown on the geologic strip map because many small patches cannot be shown at a scale of 1:250,000. This material ranges in composition from boulder moraines to clay and fine silt.

The vast bulk of the sediments mapped as glacial-alluvial material is unconsolidated to barely consolidated sand with lesser amounts of pebble to cobble size clasts. This should be relatively easy material in which to trench unless beds or lenses with a high concentration of boulders are encountered. Relatively steep terrace and river bank slopes, up to several hundred feet in height, developed in this material appear to be stable. However, vertical or near vertical faces cut into these sediments rarely last long. Within one or two winters they have weathered to sand and gravel slopes at their angle of repose.

Columbia Plateau Province

The Palouse Formation, consisting of wind blown silt-sized mineral and rock fragments called loess, covers much of the Columbia Plateau to depths of a few inches to more than 100 feet. This material, fresh, unconsolidated and unbedded, is considered by most workers to be of late Pleistocene age. Most of the loess retains its original dunelike landforms, giving rise to rolling topography. The floods that created the channeled scablands eroded away much of the loess in that area, leaving in places steepsided "islands" of loess surrounded by barren basalt. In other places, the loess has been reworked and deposited by running water. The loess maintains stable cut slopes of 30-40 degrees, but small landslides and slump features are common on slopes steeper than 40 degrees. The loess is very porous and permeable and contains few if any swelling clays. In general, the loess should be an excellent material for pipe laying purposes.

The proposed route crosses small patches of unconsolidated, poorly sorted sand and gravel in several places, especially along the Snake River. This material, deposited by the late Pleistocene floods, forms giant bars as much as 100 feet thick in places. It is readily excavated, although its cut slope stability is probably poor.

Small areas of bedded lake silt are traversed by the proposed pipeline along the Walla Walla River and in northern Oregon. This material is easily excavated and has moderate slope stability.

About 15 miles of unconsolidated to poorly consolidated tuffaceous sedimentary rocks and tuffs are crossed by the proposed pipeline southwest of the Umatilla River in northern Oregon. These rocks are fresh and contain few if any swelling clay minerals. Grain sizes vary from silt to gravel.

The Holocene alluvium is all river deposited and offers no excavation problems.

Blue Mountains Province

Surficial deposits along the Blue Mountains province segment of the proposed pipeline consist of Holocene stream channel deposits and floodplain alluvium. These are found in the 10 or so small stream crossings between Antelope Creek and Crooked River.

High Lava Plains Province

Surficial deposits along this segment of the proposed route strongly reflect their volcanic origin. Quaternary alluvium along the Crooked River consists largely of well-bedded pumiceous and cindery sediments that are interbedded with diatomite. These sediments were deposited in a lake that resulted from damming of the Crooked River by Quaternary lava flows near O'Neil. Fluviatile sediment consisting of volcanic derived sand and silt overlies the lacustrine deposits. Many of the older flows on the north and west slopes of Newberry Volcano are veneered by loess deposits of silt and fine sand that partially fill most depressions and tend to smooth the former more irregular flow surfaces. Airfall ash and pumice (Mazama Ash, 6,600 C^{14} years old) forms a thin cover on all but the youngest flows in the region. However, much of the ash has been redeposited by wind and water action so that its original uniform thickness is now uneven, being thickest in depressions and thin or absent on ridges. The Mazama ash and pumice deposits thicken southward from less than one foot near the Crooked River to about 5 feet 5 miles northeast of Bend.

Basin and Range Province

The proposed route lies on Quaternary alluvial deposits in the Sprague River and Yonna valleys and in the eastern part of the Klamath Basin near the California border. It also lies on alluvial deposits along some of the other drainages such as the Williamson River, but these deposits are not differentiated on published maps. They consist of unconsolidated river and stream sand and silt derived from the nearby volcanic highlands. Mazama ash fall and glowing avalanche deposits veneer the bedrock in the northern half of the area. The proposed route lies west of the marsh and basin deposits underlying the Klamath Marsh.

Modoc Plateau Province

Quaternary surficial deposits crossed by the route include: volcanic cinders, gravels of the Red Bluff Formation and Tuscan Formation and other continental deposits, lake beds, and Holocene alluvium.

Volcanic cinders occur on or next to the route on the flanks of at least three cinder cones: 1) Round Mountain; 2) three miles southwest of the Cow Creek crossing; and 3) Black Butte.

Two to four miles of lake beds are crossed by the proposed route in the Tule Lake basin at the Oregon border, and three miles more at Fall River, 65 miles south of Oregon. These are fine grained sediments that locally include muck and peat, plus minor amounts of sand and gravel. Both localities, especially the Fall River area, have water tables near or at the surface. Such lake beds may be susceptible to seismic amplification of

ground motion, especially where muck or peat occurs. Liquefaction potential is high where well sorted granular layers are saturated and occur near the surface.

Approximately five miles of flat or gently sloping alluvial sand and gravel are crossed by the proposed route.

Sacramento Valley Province

The proposed route is mainly on the western margin of the youngest sedimentary rocks in the structural trough known as the Great Valley. These rocks are no older than Pliocene and isotopically are dated at less than 3.4 m.y. old. The Pliocene and Pleistocene Tehama Formation includes strata that are possibly correlative with the overlying Red Bluff Formation and even younger stream terrace deposits. The proposed route intersects 20.1 miles of Tehama throughout the Great Valley. Grain size is variable in this continental sedimentary deposit that consists of more than 2,000 feet of massively bedded sandy silt, silty sand, and clayey silt. Calcium carbonate cementation is common; the clay is probably montmorillonite. Two distinct volcanic members are recognized: the Nomlaki Tuff (3.4 m.y.) and the Putah Tuff (3.2 m.y.). The Tehama is widespread in the western Sacramento Valley and is covered by no more than 150 feet of younger deposits. It is deformed, as evidenced by folds at Corning Ridge, Rumsey Hills, Copay Valley, Dunnigan Hills, and Plainfield Ridge. Bedding dips 60 degrees or more in the English Hills, but at most places dips are less than 20°.

The Red Bluff Formation of Pleistocene age unconformably overlies the Tehama Formation. It is a continental deposit consisting of poorly sorted pebble and small cobble gravel having a distinctly reddish silty or sandy matrix. This unit is nowhere greater than 50 feet thick. The route of the proposed pipeline traverses 22.1 miles of Red Bluff Formation. It is gently folded in the Rumsey Hills and Dunnigan Hills, and also near Corning. Most of the Red Bluff is above the zone of water saturation and contains only local perched ground water. Strongly developed soil profiles with thick well indurated hardpans (Corning Series) are found on the Red Bluff. These prevent water infiltration and may impede trenching. The Red Bluff is higher dissected, underlying the rolling topography on the west side of the Valley as much as 200 feet above the present Sacramento River.

The Cascade Fanglomerate is also of Pleistocene age, and crops out on the eastern side of the Sacramento Valley. Since it is derived from the Tuscan Formation, a Pliocene lahar (a mudflow composed of volcanic material), it consists of volcanic sand, gravel, and silt. Stony and gravelly clay loams of the Tuscan Soil Series have developed on the Cascade Fanglomerate. The fanglomerate is well indurated and has good cut slope stability, as demonstrated by standing vertical walls 25 feet high. The pipeline route intersects only 2.2 miles of this unit.

The Montezuma Formation is restricted to the Montezuma Hills at the southern end of the proposed route, except for a few scattered outcrops along the eastern edge of the low hills that extend northward to about Arbuckle. The Pleistocene Montezuma is quite thick and overlies the Tehama. Outcrops are scarce in the easily eroded deposit which is composed of poorly indurated sand, silt, and gravel. The sands are poorly sorted, unconsolidated, locally tuffaceous, and interbedded with sandy clayey silt and discontinuous gravels. The proposed route will intersect about 9 miles of this material.

The longest segment of the proposed route in the Sacramento Valley is in Late Pleistocene and Holocene alluvial fan deposits, 92.1 miles. Even

though they are so extensive, nowhere are these youngest units thought to be greater than 150 feet thick. These deposits display smooth depositional topography with the lowest topographic relief in the Sacramento Valley. Lithology is highly variable depending on local sources. Except for the alluvial fan deposits at Stony Creek, Cache Creek and Putah Creek, average permeability is only moderate and ground water yields are low.

Mineral Resources

Northern Rocky Mountains Province

At present, sand and gravel account for almost all of the known mineral resources within a reasonable distance of the proposed pipeline route in the Northern Rocky Mountains province. This commodity is so plentiful that any borrow pits closed by laying of the proposed pipeline would not cause any local shortages.

Clay pit operations are sporadically active in the region around Freeman, Washington. Large quantities of high-quality clay lie beneath the Palouse Formation. Through most of this area, trenching for the proposed pipeline probably will not expose clay, but it might hamper future exploitation of these deposits.

In recent years, considerable attention has been given to large, low-grade occurrences of copper in formations of the Belt Supergroup. To date, none of these occurrences have been found in the Prichard Formation, and there are no indications that the area around the proposed pipeline might be more promising for this type of deposit than other areas.

Columbia Plateau Province

Other than aggregate material, there are no known mineral resources in the proposed pipeline area. The potential for discovery of additional resources is small. The aggregate is of two types: basalt, derived from the highly jointed Yakima flows; and sand and gravel, present in the flood deposits. There are numerous small borrow pits of each type, but basalt pits predominate. The proposed pipeline should not affect or be affected by the utilization of this aggregate material.

Blue Mountains Province

The only mining activity near the proposed route in the Blue Mountain province are quarrying operations at Antelope Creek and Willow Creek. At these localities red welded tuff in the John Day Formation is being quarried for building stone about 1/2 mile off the proposed route.

High Lava Plains Province

Metallic mineral resources are not known to occur in this area and the potential for discovery is low.

Newberry Volcano east of the proposed route is one of the most attractive geothermal areas in the State. Considerable quantities of rhyolitic to basaltic lavas and tuffs have been erupted from the caldera area at its summit in recent times and two hot springs occur in the caldera. The proposed route is sufficiently far from the caldera, however, that

development of geothermal resources proximal to the proposed route is not likely.

Cinders and scoria from many of the small cinder cones near the proposed route are used for road construction and basalt from flows has locally been used for building material. Because deposits of this material are so abundant in the general region, the proposed pipeline construction will have little or no effect on local needs.

Ash flow tuff derived from vents in the Cascade Range occurs near Bend and is mined for building stone, but these deposits do not crop out along the proposed route.

Modoc Plateau Province

Known and potential geologic resources along the proposed route in northern California are generally of low economic importance. Exceptions include scenic geologic resources, and potential (undiscovered) geothermal resources.

Volcanic cinders are quarried on a small scale at several localities within a mile of the proposed route, mainly from young cinder cones. Existing or potential cinder quarries along the proposed route are found: 1) 13 miles south of the Oregon border, 2) just northeast of the proposed route crossing at Fall River, and 3) at Black Butte. These cinder quarries and other cinder cones near the proposed route provide a potential source of construction material.

Sand is taken from bluffs on and next to the proposed route on the south shore of Lake Britton. The sand pits could provide material for proposed pipeline construction.

Potential resources along the proposed route include geothermal power, diatomaceous earth, pozzolan, decorative stone, and coal.

Glass Mountain, eight miles west of the proposed route, is considered a potential geothermal resource because of very recent rhyolitic volcanism and current fumorolic activity. Although there is no indication that this geothermal field extends closer than several miles from the proposed route, undiscovered geothermal fields may be found almost anywhere in the Modoc Plateau-Cascades volcanic region.

Diatomite or diatomaceous earth in Pliocene lake beds is present along a short segment of the proposed route at the shores of Lake Britton. Its commercial usefulness and extent have not been proven, and none has been sold commercially.

Tuffs within the Tuscan Formation have been suggested as possible sources of pozzolan. Whether the proposed pipeline route crosses any suitable materials in the south part of the region is unknown.

Decorative stone is hunted by mineral collectors in parts of the widespread Tuscan Formation. It is not known if desirable material is found along the proposed pipeline route. Mineral concretions occur near the proposed route at Lake Britton.

Thin beds of low-grade coal are found in the Eocene Montgomery Springs Formation. None is described along the proposed route, and under present economic conditions the coal is not of commercial quality.

Sacramento Valley Province

Mineral resources of the area consist of local sand and gravel deposits and gas fields. Of highest interest is the Rio Vista Gas field, but the proposed pipeline passes west of the field.

Scenic Geologic Resources

Two lava flows in the Medicine Lake Highlands near the proposed route are young and scenic. The Burnt Lava Flow is a fresh flow estimated to be only 200 years old; it was proclaimed a Virgin Area by the U.S. Forest Service in 1957. Nearby Glass Mountain is a spectacular block flow of rhyolite and dacite obsidian. The U.S. National Park Service and U.S. Forest Service have recently reviewed the potential of Glass Mountain, and the whole Medicine Lake Highlands, as a scenic and recreational resource.

Lava Beds National Monument is a scenic geologic area seven miles from the proposed route.

Thousand Lakes Wilderness Area occupies a glaciated volcano adjacent to the proposed pipeline just south of Burney Mountain.

Geologic Hazards

Assessment of the seismicity along the proposed pipeline is based on both the historic and geologic record. The historic record provides the best and most accurate picture of seismicity in addition to quantitative information on which estimates of expectable magnitude and ground offsets for specific faults can be made. Study and evaluation of historic earthquakes are limited, however, in that relatively complete records of seismicity for the western United States go back only about 100 years. The recurrence interval for earthquakes on any particular fault could be longer than the historical records indicate, or the recurrence interval could be highly irregular, or both. In the evaluation of seismicity for each physiographic province that follows, both historic and geologic records have been used, but the historic record of a region is probably given more weight in the evaluation.

Since sophisticated quantitative measurements of earthquakes were not possible until the second or third decade of this century, the most complete historical record is described in terms of intensity (a measure of observed effects of seismic tremors). Both intensity and magnitude are presented where information is available. Unless otherwise noted, intensity is given in terms of the Modified Mercalli Scale, and magnitude given in terms of the Richter scale. The following is a rough comparison of intensity and magnitude prepared empirically from historic earthquake data for which magnitude and maximum intensity have been determined.

Magnitude	Intensity
7-3/4 to 9	XI to XII
7 to 7-3/4	X to XI
6-1/4 to 7	VIII to X
5-1/2 to 6-1/4	VII to VII

This comparison is approximate, since intensity is dependent on local conditions and the determination of intensity is somewhat subjective.

An attempt to assess maximum expectable acceleration has not been made since a reliable relationship between acceleration and magnitude on one hand, and acceleration and intensity on the other, has not been determined.

Figure 2.1.4.3-13 is a map of historic earthquakes upon which the proposed pipeline route has been plotted.

The following table summarizes the maximum expectable intensity, magnitude, and displacement for the most seismically active parts of the proposed route:

	Intensity	Magnitude	Displacement
Umatilla Walla Walla region	VII	6	Probably none
Southern Great Valley-Antioch	IX - X	8	Unknown

Northern Rocky Mountains Province

The portion of the Northern Rocky Mountain province traversed by the proposed pipeline lies in seismic risk zone 2 (Figure 2.1.4.3-14). Only 2 earthquakes of any consequence have been recorded in the region. The stronger shock occurred in 1942, had an intensity of VI, and an epicenter near Granite, Idaho, eight miles east of the nearest point on the proposed pipeline right-of-way. The other shock, intensity V, occurred at Rathdrum, Idaho, in 1918. Rathdrum is less than a mile west of the proposed pipeline route. None of the known or inferred faults shown on the map (Figure 2.1.4.3-2) that are crossed by the proposed pipeline in this physiographic province are known to be active or show any primary fault features along their surface traces, and none are known to cut Quaternary deposits.

In the event an earthquake capable of producing severe ground shaking did occur, two stretches along the proposed route might be susceptible to liquefaction due to local highs in the water table: 1) between Colburn and Sandpoint, and 2) between Naples and Elmira. Based on available data, it appears unlikely that an earthquake as large as intensity VII or magnitude 5.5 will occur in this province.

Columbia Plateau Province

The proposed pipeline route in the Columbia Plateau province is in seismic risk zone 2, except for a small part in seismic risk zone 1 (Figure 2.1.4.3-14). The Columbia Plateau province is listed as an area of moderate seismic risk. Twelve historic earthquakes (through 1970) of intensity VIII or less (only one of intensity VIII) have been felt within about 100 miles of the proposed route. Of these, less than half appear to have been generated locally, the rest being distant quakes centered in western Washington or Montana.

Two moderate earthquakes, both intensity VII, have occurred in northern Oregon near the proposed route. The closest occurred March 6, 1893 at Umatilla, about 10 miles northwest of the proposed route. On July 15, 1936, a magnitude 5.75 quake was centered near Milton-Freewater about 20 miles southeast of the proposed route. This earthquake was felt over about 100,000 square miles. During this earthquake, ground cracking was extensive in the general vicinity of the town. Some cracks were 200 feet long, the largest was 3 feet wide and 8 feet deep. Water issued from many of the cracks. This general area is near the eastward projection of the Wallula

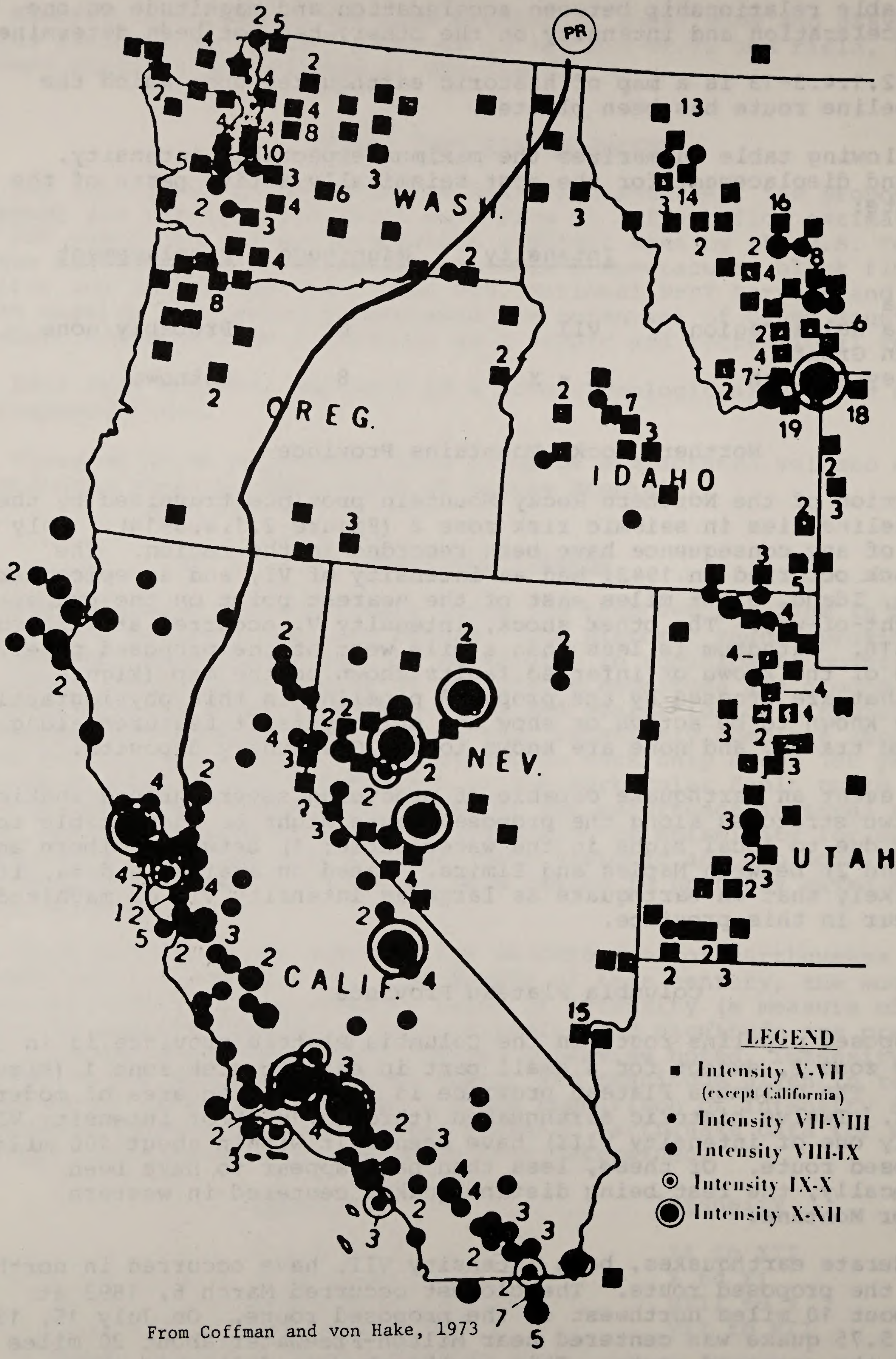
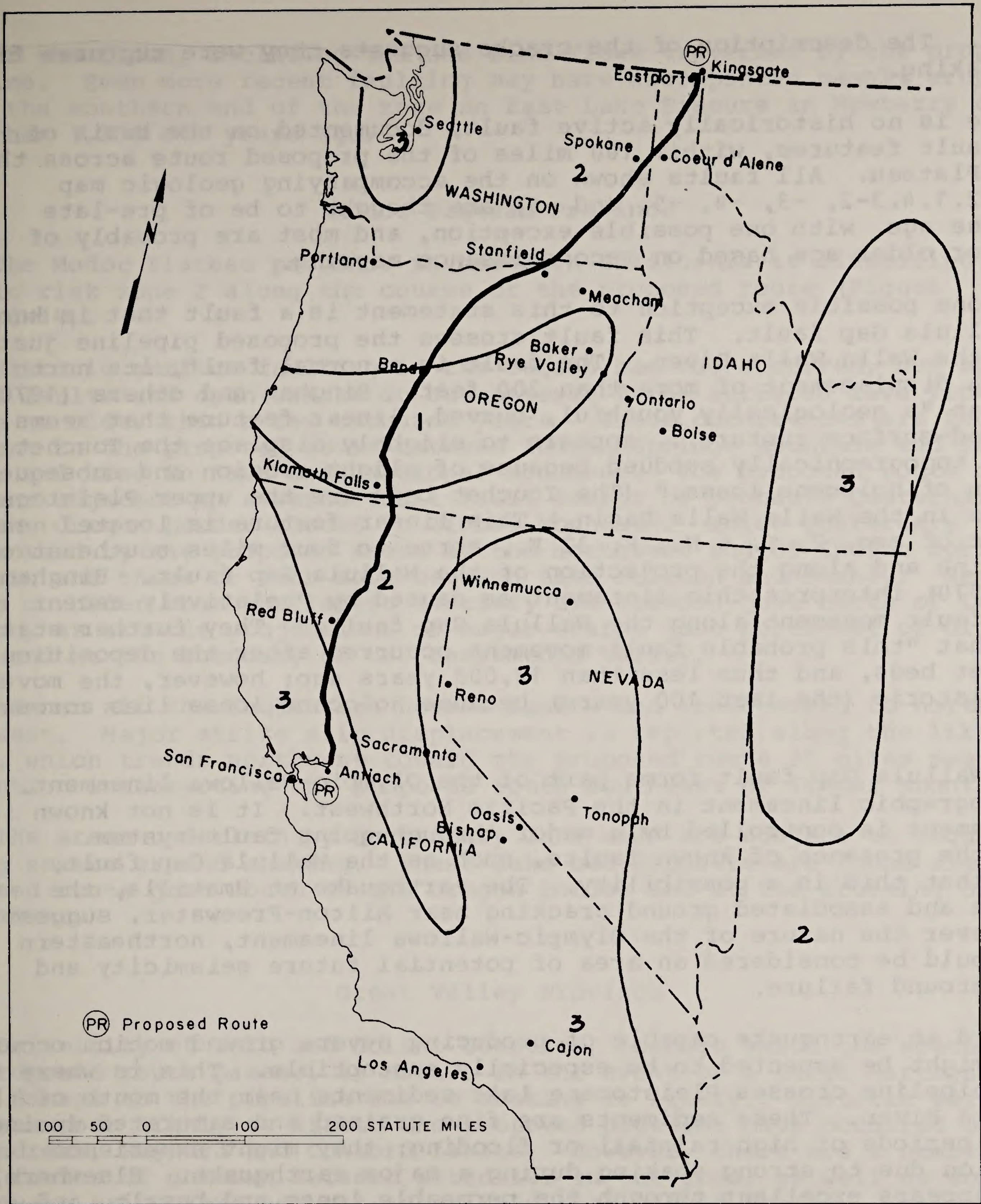


Figure 2.1.4.3-13 Earthquakes in the western United States through 1970



EXPLANATION

SEISMIC RISK ZONES (After Algermissen, 1969)

ZONE 0 - No damage (not indicated on this map)
ZONE 1 - Minor damage; distant earthquakes may cause damage to structures with fundamental periods greater than 1.0 seconds; corresponds to intensities V and VI of the M.M.* Scale.
ZONE 2 - Moderate damage; corresponds to intensity VII of the M.M.* Scale.
ZONE 3 - Major damage; corresponds to intensity VIII and higher of the M.M.* Scale.

This map based on the known distribution of damaging earthquakes and the M.M.* intensities associated with these earthquakes; evidence of strain release; and consideration of major geologic structures and provinces believed to be associated with earthquake activity. The probable frequency of occurrence of damaging earthquakes in each zone was not considered in assigning rating to the various zones.

* Modified Mercalli Intensity Scale of 1931.

Figure 2.1.4.3-14 Seismic risk zones in the region of the proposed pipeline route

Gap fault. The description of the cracks suggests they were ruptures from ground shaking.

There is no historically active fault, documented on the basis of primary fault features, within 100 miles of the proposed route across the Columbia Plateau. All faults shown on the accompanying geologic map (Figures 2.1.4.3-2, -3, -4, -5, and -6) are thought to be of pre-late Pleistocene age, with one possible exception, and most are probably of Pliocene or older age based on reconnaissance mapping.

The one possible exception to this statement is a fault that is known as the Wallula Gap fault. This fault crosses the proposed pipeline just south of the Walla Walla River. The fault is a normal fault, its north side down, with displacement of more than 200 feet. Bingham and others (1970) report that "a geologically youthful, curved, linear feature that seems to be a ground-surface rupture... appears to slightly displace the Touchet beds but to be topographically subdued because of slight erosion and subsequent deposition of Holocene loess." (The Touchet beds are the upper Pleistocene lake silts in the Walla Walla Basin.) This linear feature is located near the center of sec. 2, T. 6 N., R. 32 E., three to four miles southeast of the pipeline and along the projection of the Wallula Gap fault. Bingham and others (1970) interpret this lineament as caused by "relatively recent tectonic fault movement along the Wallula Gap fault." They further state (p. 71) that "this probable fault movement occurred after the deposition of the Touchet beds, and thus less than 12,000 years ago; however, the movement was not historic (the last 100 years) because Holocene loess lies across the fault."

The Wallula Gap fault forms part of the Olympic-Wallowa lineament, a major topographic lineament in the Pacific Northwest. It is not known if this lineament is controlled by a major through-going fault system. However, the presence of known faults, such as the Wallula Gap fault, suggests that this is a possibility. The earthquake at Umatilla, the earthquake and associated ground cracking near Milton-Freewater, suggest that whatever the nature of the Olympic-Wallowa lineament, northeastern Oregon should be considered an area of potential future seismicity and possible ground failure.

Should an earthquake capable of producing severe ground motion occur, one area might be expected to be especially susceptible. This is where the proposed pipeline crosses Pleistocene lake sediments near the mouth of the Walla Walla River. These sediments are fine grained and saturated during winter or periods of high rainfall or flooding; they might experience liquefaction due to strong shaking during a major earthquake. Elsewhere, drainage appears excellent through the permeable loess and basalt, and severe ground motion or liquefaction probably would not occur.

High Lava Plains Province

The region of the High Lava Plains traversed by the proposed pipeline lies in seismic risk zone 1. This is one of the most aseismic areas in Oregon. Nevertheless, numerous faults that displace Quaternary rocks occur near the proposed route and in adjacent areas. The Quaternary basalt flows along the proposed route north of Bend are not faulted. However, this area lies directly on the westward projection of the Brothers fault zone, along which numerous faults with vertical displacements of as much as a few hundred feet offset Quaternary and older rocks. The Northwest Rift Zone of Newberry Volcano intersects the proposed route (see geologic strip map (Figure 2.1.4.3-7). Displacement along faults in this zone occurred about 5,800 years ago, probably concomittant with eruption of lava which forms

many of the flows, including the Gas Line Flows traversed by the proposed pipeline. Even more recent faulting may have accompanied basalt eruptions along the southern end of the zone on East Lake Fissure in Newberry caldera less than 1,970 C^{14} years ago.

Modoc Plateau Province

The Modoc Plateau province in northern California is classified as seismic risk zone 2 along the course of the proposed route (Figure 2.1.4.3-14).

Historic surface faulting in the region has not occurred, but small normal faults and open cracks do cut several fresh surfaced lava flows that can be no older than a few thousand years. These occurrences are found adjacent to the proposed route between Indian Springs Mountain and Fall River, and also in Lava Beds National Monument. The proposed route crosses and runs adjacent to several small fault scarps of probable Quaternary age from the Oregon border almost to Timber Mountain. Three Quaternary scarps are crossed by the proposed route at the northwest end of Indian Springs Mountain and three or four more between Lake Britton and Burney. Several scarps no older than the latest Tertiary are crossed just north of Lake Britton, as are the projections of major scarps just northeast of Old Cow Creek and at the boundary of the Sacramento Valley.

Almost all the faults are normal faults and trend north to north-northwest. Major strike slip displacement is reported along the likely fault, which trends northwest toward the proposed route 25 miles away, the projection intersecting the proposed route southeast of Timber Mountain.

The areas underlain by Quaternary lake beds are subject to liquefaction during severe ground shaking. These lake bed deposits are found along the proposed route just south of the Oregon border and at the crossing of the Fall River.

Great Valley Province

Seismicity of Yolo and Solano Counties, through which the south part of the proposed route passes, is high. In the event of a large earthquake major damage to the pipeline due to shaking is likely. Historic earthquakes in areas most likely to affect the proposed pipeline have occurred on the San Andreas, Hayward and Concord faults. However, there are a number of other faults of unknown seismic potential in the area, as well as some earthquake epicenters not yet associated with ground breaks. Maximum historic shaking intensity recorded in the area is Modified Mercalli IX at Vacaville and Winters in two separate earthquakes, April 19, 1892, and April 21, 1892.

Table 2.1.4.3-1 is an extract which indicates earthquakes that could have affected the proposed right-of-way of the pipeline. In some older earthquakes vital data needed for assessment of shaking intensities is absent. However, these earthquakes are included and will at least contribute to estimates of earthquake frequency.

Faults with documented historic activity may be subdivided into two groups: 1) those likely to cause rupture to structures built on or near the fault, and 2) those likely to generate an earthquake whose shaking could cause substantial deformational effects to nearby structures.

Table 2.1.4.3-1 Earthquakes 1808-1970 which could have affected the proposed route in the Great Valley Province

Year	Date	Locality	N. Lat	W.Long	Sq. Miles Affected	I_{mm}
1808 1/	21 June	Presidio, S. F.	38°	122.5°	?	?
1836 2/	10 June	San Francisco Bay	38°	122°	?	IX-X
1838	June	San Francisco Region	37.5°	122.5°	?	X
1851 1/	15 May	San Francisco	37.5°	122.5°	?	VI
1857	5 Feb.	San Francisco	37.5°	122.5°	?	VIII
1861 3/	3 July	Contra Costa and Alameda Counties	37.5°	122°	?	VIII
1864 1/	5 Mar.	San Francisco	37.5°	122.5°	?	VI
1865 1/	8 Oct.	Santa Cruz Mountains	37°	122°	?	VIII-IX
1866	26 Mar.	San Francisco Region	?	?	?	?
1868 2/	21 Oct.	Hayward	37.5°	122°	?	IX-X
1884	25 Mar.	San Francisco	37.5°	122°	?	?
1888 2/	18 Nov.	Oakland	37.5°	122.5°	?	VII
1889 4/	19 May	Collinsville-Antioch	38°	122°	?	VII
1889 2/	31 July	San Francisco Bay	37.5°	122°	?	VII
1892 ?/	19 Apr.	Vacaville	38.5°	122.5°	?	IX
1892 ?/	21 Apr.	Winters	38.5°	122°	?	IX
1898 ?/	30 Mar.	Mare Island	38°	122°	?	VII
1899	1 June	San Francisco	37.5°	122.5°	?	VI
1906 1/	18 Apr.	Northwest of San Francisco	38°	123°	375,000	XI
1915	7 Oct.	Piedmont	37.5°	122°		VI
1952 1/	21 Oct.	San Francisco Bay	37.9°	122.4°	2,500	V
1955 5/	23 Oct.	Near Concord	38.0°	122.1°	12,000	VII
1958 1/	22 Mar.	West of Daly City	37.7°	122.5°	12,000	VII
1963 4/	7 June	Near Antioch	38.0°	121.8°	1,500	VI
1970 3/	11 June	Danville	37.8°	121.9°	1,300	VI
1970 3/	12 June	Danville	37.8°	121.9°	--	VI

1/ Origin probably on San Andreas fault.
2/ Origin probably on Hayward fault.
3/ Origin on Calaveras fault.
4/ Origin probably on Antioch fault.
5/ Origin probably on Concord fault.

Source: John D. Sims, U.S. Geological Survey (Unpublished compilation, 1974).

The first group is represented by the Antioch fault and its possible extension northwestward through Collinsville, the southwestern Montezuma Hills, and on to the vicinity of Little Honker Bay. Little is known of this fault or fault system. The 1892 earthquakes at Vacaville and Winters may have been on fault segments associated with the Antioch fault.

The second group of faults include: the Concord-Green Valley fault group, Calaveras fault, Pleasanton fault, Livermore fault, Verona fault, Hayward fault and San Andreas fault, in addition to three unnamed faults with Quaternary movement. Two of these faults are northeast of Livermore, midway in Alameda County. The other is just west of Zamora in Yolo County.

Areas Susceptible to Liquefaction

Areas most likely to suffer from liquefaction during earthquake shaking are those low lying areas south of Dozier and north of the Montezuma Hills, Sherman Island (which is 12 or 15 feet below sea level), and the area underlain by bay mud that borders the San Joaquin River. Areas of lower liquefaction potential are in the Montezuma Hills in areas underlain by Quaternary stream deposits and terrace deposits, and in stream and terrace deposits associated with Cache Creek, Putah Creek, Eulatis Creek, and their tributaries.

Landslides, Subsidence, and Erosion

Northern Rocky Mountains Province

Although geologic mapping in the Moyie River valley is sketchy, there are indications that bedding in the Belt rocks dip steeply into the Moyie River valley from both sides in the north part of the valley. If thin bedded argillitic or siltitic rocks are present in any of the areas where the walls of the valley are steep and the bedding dips downslope, these areas should be considered potentially landslide prone.

Columbia Plateau Province

Small slides and slumps can be expected on steep loess hills. Steep hillsides along major valleys, especially the Palouse, Snake, Touchet, and John Day Valleys, are also susceptible to sliding. Talus cones of basaltic debris occur along the Snake Valley and should be avoided because of their instability.

The upper Pleistocene lake silts near Walla Walla could be susceptible to sudden subsidence if they are water saturated during a large earthquake. Loess in both the Columbia Plateau and Blue Mountain provinces is susceptible to gullying, especially on steep slopes.

Blue Mountains Province

Landslides are common where the Clarno and especially the John Day Formations crop out. Most of these slides probably reached their peak activity during the Pleistocene age, when climatic conditions were wetter than today. Many slides are still active and many others may be so unstable that trenching could reactivate parts of them. Removal of material in the lower parts of a landslide could remove support of a mass and cause it to move. Most of the landslides active today creep nearly continuously, with accelerated periods during times of high rainfall or high rate of snow

melting. Areas most susceptible to sliding are those in which the bentonitic tuffs of the John Day Formation are tilted and overlain by Columbia River basalt. If lateral support is removed from such areas, either naturally or artifically, landslides commonly result, especially during wet periods. The area of landslides where the proposed pipeline leaves the Columbia Plateau and enters the John Day Formation is a good example.

Basin and Range Province

No landslides are shown on published geologic maps near the proposed route. Basalt flows which underlie much of the route have generally low landslide susceptibility. However, the moderately to poorly consolidated sediments of late Tertiary age near the Sprague River valley and farther south may be subject to landsliding or slumping where they crop out on steeper slopes, particularly where they are capped by younger basalt flows.

Subsidence is probably minimal along this section of the proposed route. Much of the proposed route is over volcanic rocks, and valleys traversed by the route have water tables that lie very close to the surface.

Modoc Plateau Province

Landslides are common on dip slopes from Cow Creek south, especially in the Montgomery Creek Formation. The proposed pipeline crosses a landslide on the north slope of North Fork Bear Creek. Large landslides and associated surface faulting may be encountered in the Tuscan Formation, near the Sacramento Valley, due to failure in the underlying Montgomery Creek Formation. Such landslide movements can be large.

Local subsidence is a problem where the route crosses pahoehoe lavas because of the potential collapse of numerous lava tubes and cavities. The route passes adjacent to the Mayfield Ice Cave at Indian Springs Mountain, and within a few miles northwest of one of the largest lava tubes known. Two caves are shown on U.S. Forest Service Maps near the route northwest of Timber Mountain. Most problems of lava tube collapse are likely to be encountered during construction.

Volcanism

Basin and Range Province

The volcanic rocks along the pipeline route are of early Pleistocene age, except for some flows in the northern part derived mostly from vents along the west slope of the Cascade Range which could be late Pleistocene. Volcanic activity is unlikely in the near future except in the adjacent Cascade Range. Even in this segment of the range, no historic eruptions are recorded and probability of near future eruptions is low.

High Lava Plains Province

Because of the youthful age and primary constructional nature of the volcanic terrane of the High Lava Plains, potential volcanic eruptions must be considered a major geologic hazard.

The proposed pipeline route in this region is underlain by Quaternary volcanic rocks. Eruptions along the Northwest Rift Zone of Newberry

Volcano, occurred about 5,800 and less than 1,970 radiocarbon years ago. Volcanic activity of similarly recent age has also occurred in the caldera atop Newberry Volcano. Some obsidian flows and pumice and ash deposits there are only 1,270 to 5,000 radiocarbon years old. Eruptions from the central pumice cone produced pumice and ash deposits that extend at least 20 miles to the east and cover the entire east flank of the volcano to a depth of 1 to more than 20 feet. The distribution of the ash and pumice was controlled by strong prevailing winds from the west and northwest during the eruption. Earlier eruptions from the present area of the caldera produced welded ash flow tuffs that are 20 to 120 feet thick in the caldera's east wall and over 20 feet thick (base not exposed) about 10 miles northeast of the caldera. This ash flow tuff has not been observed on the west flank of Newberry Volcano, which the proposed pipeline route traverses, but may be buried by younger basalt flows. Ash flows are not significantly influenced by high altitude winds as are air fall tuffs, so that future eruptions are as likely to affect the west side of the volcano as they are the east.

About 1-1/2 miles south of the crossing of the Gas Line Flows the proposed pipeline route passes 500 feet east of Lava River Cave State Park. Lava River Cave, a lava tube that is open to the public and of high tourist attraction because of its proximity to U.S. Highway 97, extends one mile northwest of the collapse formed opening at the Park. The southeast part of the lava tube which is closed to the public probably extends under the proposed pipeline route. Continuing southward the proposed route passes over older (Quaternary) flows of the west flank of Newberry Volcano, many of which end with steep faces near the proposed route. These older flows are forest covered and their surfaces, although locally rough due to tumuli and pressure ridges, are slightly modified by erosion and mantled by ash and loess. The proposed route crosses a small cinder cone, located just below the Lava River Cave State Park. It is one of a series of cones aligned along a north northwest trending fissure.

The adjacent part of the Cascade Range is also one of young volcanic activity. The young basalt and andesite flows are mainly restricted to the area around their vents, and ash falls and ash flows may affect much larger areas. Late Pleistocene ash flow tuffs derived from a vent on the east side of Broken Top Mountain west of Bend are locally exposed below young basalt flows west and northwest of the pipeline route. Holocene or latest Pleistocene pumiceous-glowing avalanche deposits crop out in the same area and were probably also derived from a vent in the Three Sisters-Broken Top area.

Modoc Plateau Province

The region traversed in this province is one of active volcanism. Historic eruptions within 25 miles of the proposed route have occurred at Mount Lassen in 1915, at Cinder Cone (also in Lassen Park) in 1851, and possibly at Glass Mountain in 1910. Other eruptions have occurred within the last several hundred years at Chaos Crags (in Lassen Park), Burnt Lava Flow, and probably Glass Mountain. This short record indicates eruptions within 25 miles of the proposed pipeline route in California have been recurring at intervals averaging perhaps 50 or 100 years, although it is not possible to state that another eruption will occur 50 to 100 years since the last one.

Eruptions could produce ash falls, ash flows, mud flows, or lava flows. A distant eruption of ash could blanket the proposed pipeline route but probably would have little effect on a buried pipeline. More destructive than ash falls are hot ash flows and volcanic mudflows (lahars). Destructive lahars with erosional potential could follow streambeds and cut

the proposed pipeline if a winter eruption should occur near the (post-glacial) Burney Mountain Volcano or in the Lassen Peak area. Lahars or ash flows could occur with advance warning of less than one day.

The route also may be covered or cut by lava. Approximately 15 miles (10 percent) of the proposed pipeline route in northern California is on lavas mapped as recent (Holocene) in age on the Geologic Map of California. These represent about five eruptive centers. It is not known if the increased load could stress the pipe to the point of rupture.

2.1.4.4 Soils

The soils along the proposed pipeline route will be disturbed during the clearing of the right-of-way, installation of the pipeline, construction of access roads and accessory facilities, and performance of many operational, service, and maintenance functions. Once disturbed, soils are subject to wind and water erosion and are a source of pollution of lakes and streams.

Their function in support of plant life may be significantly impaired. Critical evaluations of the short and long term effects of pipeline construction on the total environment must involve primary consideration of the pipeline effect on the soil component.

The proposed pipeline from the Canadian border at Eastport, Idaho to Antioch, California crosses many diverse landscapes which contain about 149 Major Soil Series. Definite boundaries between the identified soil series have not been defined, nor has detail sampling and testing for physical and chemical properties been conducted. As a result, the soil series have been consolidated into soil associations.

Soil Classification

The present system of soil classification used in the United States includes, beginning with the broadest category: order, suborders, great groups, subgroups, families, and series.

In this report the maps which are provided on a state by state basis show groupings of associated soil series referred to as soil associations.

Soil associations consist of soil series that occur in a regular repeating pattern on the landscape and can be easily grouped for mapping purposes. Within any delineated association, only two or three soil series are named but there usually are lesser amounts of other series which are not named. The term "soil series" refers to soils essentially uniform in differentiating characteristics and in arrangement of soil layers.

Soil series are differentiated on the basis of the color, texture, structure, and chemical nature of each horizon; the number, thickness, and sequence of horizons; the thickness of the solum or true soil, i.e., the combined thickness of the surface and subsoil horizons; and the origin and nature of the parent material. Significant variation in one or more of these characteristics is the basis for distinguishing the various series. The name of a soils series is to identify an individual soil series and has no reference as to its characteristics. Soils with the same series name in different areas have similar properties within the range defined for the particular series.

Soil Associations Along the Proposed Route

Listed below are brief descriptions of the major soil associations and series encountered along the proposed route. Data are not available to quantify the distances of each soil series crossed. This information is available locally for some areas but a detailed soil survey of the proposed pipeline route has not been prepared. The soil associations crossed are shown on the state maps (Figures 2.1.4.4-1 through 2.1.4.4-4). Major soil characteristics for dominant soil series likely to be encountered are included for each state (Tables 2.1.4.4-1 through 2.1.4.4-4).

Idaho Soil Associations

(See Figure 2.1.4.4-1, Idaho Soil Associations, and Table 2.1.4.4-1, Selected Soil Characteristics in Idaho.)

Washington Soil Associations

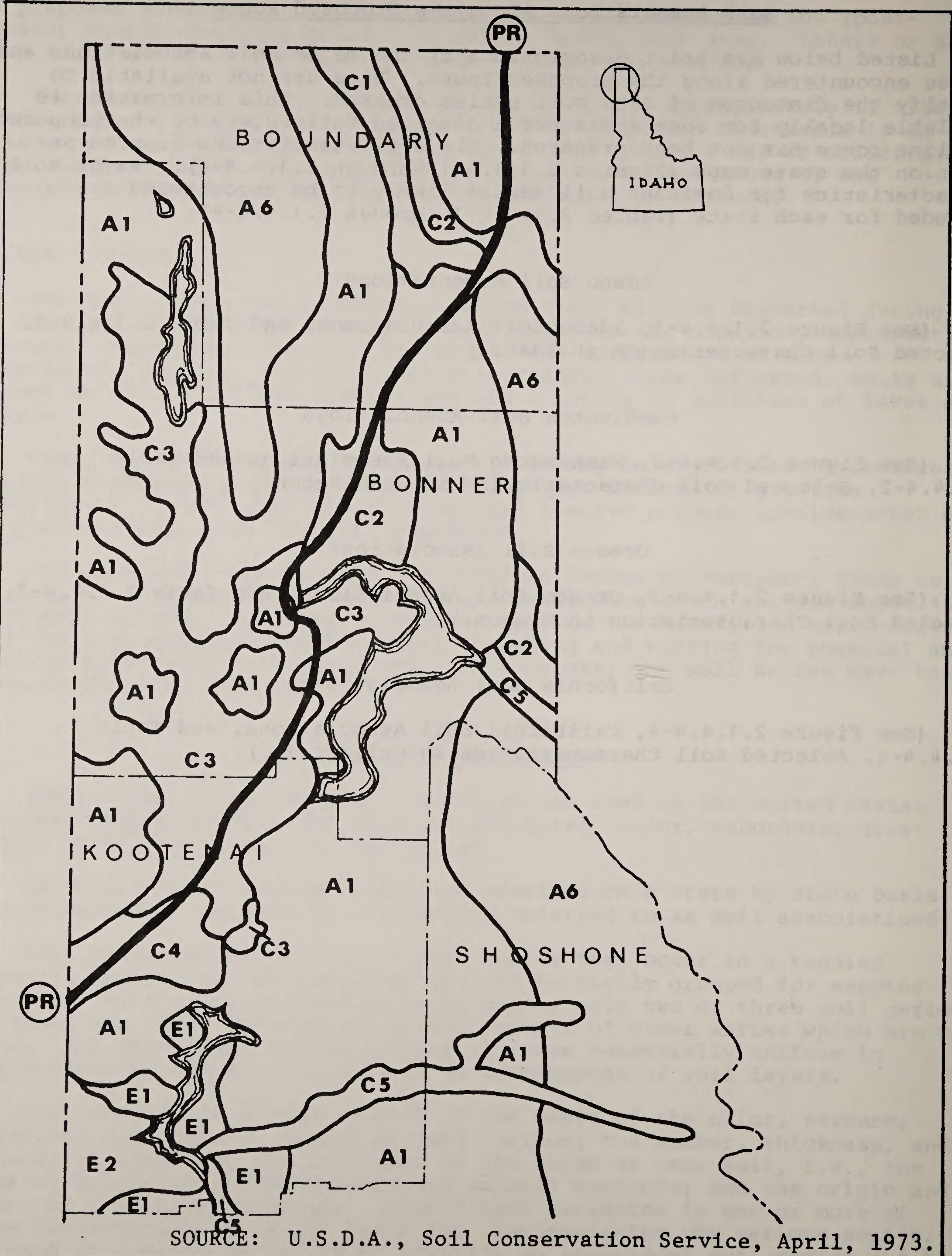
(See Figure 2.1.4.4-2, Washington Soil Associations and Table 2.1.4.4-2, Selected Soil Characteristics in Washington.)

Oregon Soil Associations

(See Figure 2.1.4.4-3, Oregon Soil Associations, and Table 2.1.4.4-3, Selected Soil Characteristics in Oregon.)

California Soil Associations

(See Figure 2.1.4.4-4, California Soil Associations, and Table 2.1.4.4-4, Selected Soil Characteristics in California.)



SOURCE: U.S.D.A., Soil Conservation Service, April, 1973.

Figure 2.1.4.4-1 Idaho soil associations

Legend, Figure 2.1.4.4-1 Idaho Soil Associations

A. STONY MEDIUM TO COARSE TEXTURED, LIGHT AND DARK COLORED SOILS, MODERATELY STEEP AND STEEP MOUNTAINOUS--DOMINANTLY FORESTED.

A1 Shallow to deep, well-drained, slightly to strongly acid, stony silt loam soils that are moderately steep and steep, and formed in material weathered from metamorphosed and acid igneous rocks, glacial till, and volcanic ash--20 to 60 inches annual precipitation. (Huckleberry-Jughandle-Waits-Moscow)

C. MODERATELY COARSE TO MODERATELY FINE TEXTURED LIGHT AND DARK COLORED SOILS THAT ARE NEARLY LEVEL TO SLOPING, AND FORMED IN ALLUVIUM, LAKE SEDIMENTS, AND GLACIAL OUTWASH-GRASSLAND, FOREST.

C1 Deep, poorly drained medium acid to mildly alkaline, silty clay loam and peat soils that are nearly level, and formed in mixed alluvium and decomposed organic matter--19 to 23 inches annual precipitation. (Ritz-Farnhamton-DeVoignes)

C2 Moderately deep over gravel and deep, well-drained, neutral to slightly acid, silt loam to loamy sand soils that are nearly level to sloping, and formed in lake sediments and glacial outwash--19 to 32 incles annual precipitation. (Porthill-Bonner-Mission-Elmira)

C3 Moderately deep over gravel and deep well-drained, neutral to slightly acid, loam, gravelly loam and silt loam soils that are nearly level to sloping, and formed in glacial outwash and till--25 to 32 inches annual precipitation. (Bonner-Pend Oreille)

C4 Moderately deep over gravel and deep, well to excessively drained, medium acid to neutral, gravelly silt loam soils that are nearly level to sloping, and formed in glacial outwash and till--20 to 22 inches annual precipitation. (Garrison-Hagen-Marble)

Table 2.1.4.4-1 Selected soil characteristics in Idaho

Soil Series	Land Position	Thickness of Surface Layer	Dominant Surface Texture	Subsoil Texture	Underlying Material	Depth to Bedrock	Soil pH	Permeability	Slope Group Percent
A1									
Huckleberry	Rolling Uplands	3"	SL	SIL	Shale	20-40"	6.0-6.6	Moderate	15-70%
Jughandle	Steep Uplands	1"	SL	SL	Granite	24-60"	5.2-6.1	Moderately Rapid	5-70%
Waits	Sloping Uplands	2"	SL	L	Gravelly Loam	>60"	6.2-8.2	Moderate	5-70%
Moscow	Sloping Uplands	1"	SL	L	Granite	20-40"	5.8-5.1	Moderate	5-70%
C1									
Ritz	Flood Plain	8"	SIL	SIL	SIL	>60"	7.6-8.0	Moderate	0-6%
Farnhamton	Flood Plain	8"	SIL	SIL	SIL	>60"	7.6-8.0	Moderate	0-6%
C2									
Porthill	Terraces	9"	SIL	SICL	Calcareous sediments	>60"	6.2-8.4	Slow	0-6%
Bonner	Terraces	2"	LS	S	GS	>60"	6.3-6.7	Moderately Rapid to Rapid	0-6%
Mission	Terraces	3"	SL	SICL	SICL	>60"	6.5-8.0	Slow	0-6%
Elmira	Terraces	4"	LS	S	Sand	>60"	6.2-6.4	Rapid	0-6%
C3									
Bonner	Terraces	2"	LS	S	GS	>60"	6.3-6.7	Moderately Rapid to Rapid	0-6%
Pend Oreille	Steep Uplands	3"	SL	SIL	CSL	>60"	5.7-5.8	Moderate	5-70%
C4									
Garrison	Alluvial Fans and Terraces	16"	L	GL	GS	>60"	6.8-7.6	Moderately Rapid	0-6%
Hager	Uplands	4"	SL	SL	LS	>60"	6.2-7.0	Rapid	0-6%
Marble	Terraces	3"	LS	SL	Sand	>60"	6.4-7.0	Rapid	0-25%

Soil Texture: S--Sand; SI--Silt; C--Clay; L--Loam; G--Gravel

This table developed from: National Cooperative Soil Survey Reports, Soil Conservation Service.

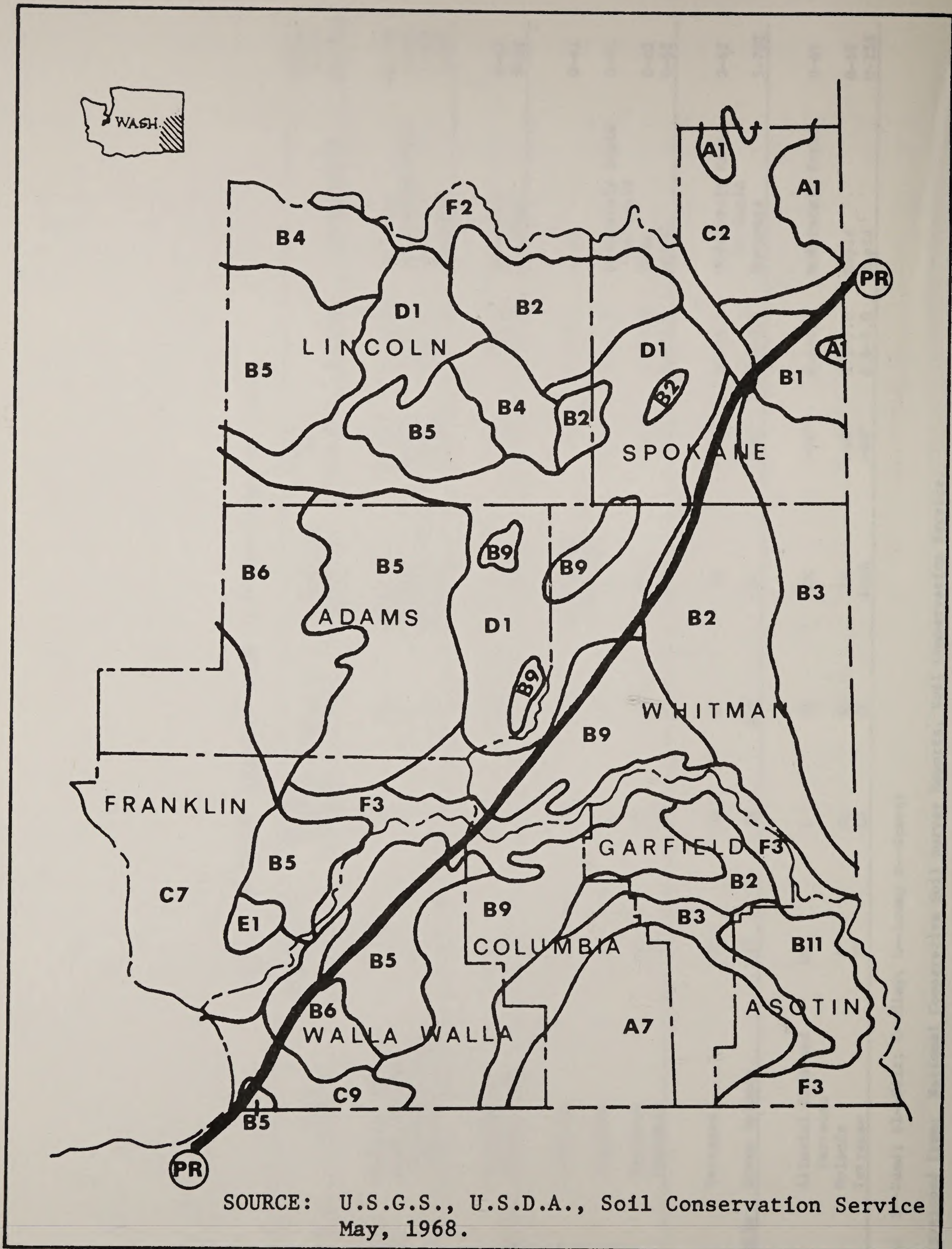


Figure 2.1.4.4-2 Washington soil associations

Legend, Figure 2.1.4.4-2, Washington Soil Associations

B. SOILS OF NEARLY LEVEL TO VERY STEEP LOESSIAL UPLAND--DOMINANTLY GRASSLAND, WITH SOME SHRUBS.

B1 Deep, loam and silt loam soils formed in wind-laid silts and glacial till and outwash. (Freeman-Nez Perce-Naff)

B2 Deep, silt loam soils formed in wind-laid silts. (Athena-Tucannon)

B5 Shallow to deep, silt loam and loam soils formed in wind-laid silts, glacial outwash, and alluvium. (Ritzville-Willis-Starbuck)

B6 Shallow to deep, silt loam soils formed in wind-laid silts, old sediments, and glacial outwash. (Shano-Burke-Starbuck-Warden)

B9 Shallow to deep, silt loam and loam soils formed in wind-laid silts. (Walla Walla-Ritzville-Endicott-Kuhl)

C. SOILS OF NEARLY LEVEL TO STRONGLY SLOPING VALLEYS, TERRACES, PLATEAUS, AND TILL PLAINS--DOMINANTLY GRASSLAND, WITH SOME SHRUBS AND FOREST.

C3 Deep, sand, sandy loam, and loam soils, some of which are gravelly or stony, formed in glacial outwash--16 to 20 inches annual precipitation. (Garrison-Marble)

C9 Deep, silt loam, sandy loam, and sandy soils formed in wind-laid silts and sands. (Warden-Quincy-Naches)

D. SOILS OF NEARLY LEVEL TO MODERATELY STEEP CHANNELED SCABLAND--DOMINANTLY GRASSLAND AND SOME SHRUBS.

D1 Shallow and moderately deep, loam and silt loam soils formed in wind-laid silts, glacial outwash, volcanic ash, pumice, and weathered bedrock. (Hesseltine-Stratford-Benge-Rockland)

F. SOILS OF STEEP AND VERY STEEP CANYON BREAKS--GRASSLAND, FOREST, AND SHRUBS.

F3 Shallow to deep, sandy loam, loam, and silt loam soils, underlain by bedrock or sand and gravel at a depth of 20 to 40 inches, formed in colluvium, alluvium, and weathered basalt. (Kuhl-Starbuck-Magallon-Linville)

Table 2.1.4.4-2 Selected soil characteristics in Washington

Soil Series	Land Position	Thickness of Surface Layer	Dominant Surface Texture	Subsoil Texture	Underlying Material	Depth to Bedrock	Soil pH	Permeability	Slope Group Percent
B1									
Freeman	Rolling Uplands	17"	SIL	SIL	SICL	> 60"	6.6-6.8	Very Slow	
Nez Perce	Uplands	20"	SIL	SIC	SICL	> 60"	6.3-8.0	Slow	0-25%
Naff	Uplands	17"	SIL	SICL	SICL	> 60"	6.6-6.8	Slow	7-40%
B2									
Tucannon	Uplands	11"	SIL	SIL	Basalt Bedrock	20-40"	6.2-6.8	Moderate	7-40%
Athena	Uplands	9"	SIL	SIL	SIL	> 60"	7.0-8.5	Moderate	5-70%
B5									
Ritzville	Uplands	9"	SIL	SIL	SIL	> 60"	6.8-8.5	Moderate	0-65%
Willis	Uplands	8"	SIL	SIL	Cemented Hard-pan	20-40"	7.4-8.6	Moderate	7-40%
Starbuck	Uplands	9"	SIL	SIL	Basalt Bedrock	12-20"	6.6-7.0	Moderate	0-65%
B6									
Shano	Uplands	8"	SIL	SIL	SIL	> 60"	7.6-9.0	Moderate	0-15%
Burke	Uplands	4"	SIL	SIL	Cemented Duri-pan	15-40"	7.8-8.4	Moderate	0-25%
Starbuck	Uplands	9"	SIL	SIL	Basalt Bedrock	12-20"	6.6-7.0	Moderate	0-65%
Warden	Terraces	6"	SL	SIL	SIL	> 60"	7.8-8.6	Moderate	0-65%
B9									
Ritzville	Uplands	9"	SIL	SIL	SIL	> 60"	6.8-8.5	Moderate	0-65%
Endicott	Uplands	12"	SIL	SIL	Cemented Hard-pan	20-60"	7.5-8.0	Moderate	7-40%
Kuhl	Plateaus and Canyon Slopes	11"	Stony SIL	Stony SIL	Basalt Bedrock	10-20"	7.4-7.6	Moderate	0-65%

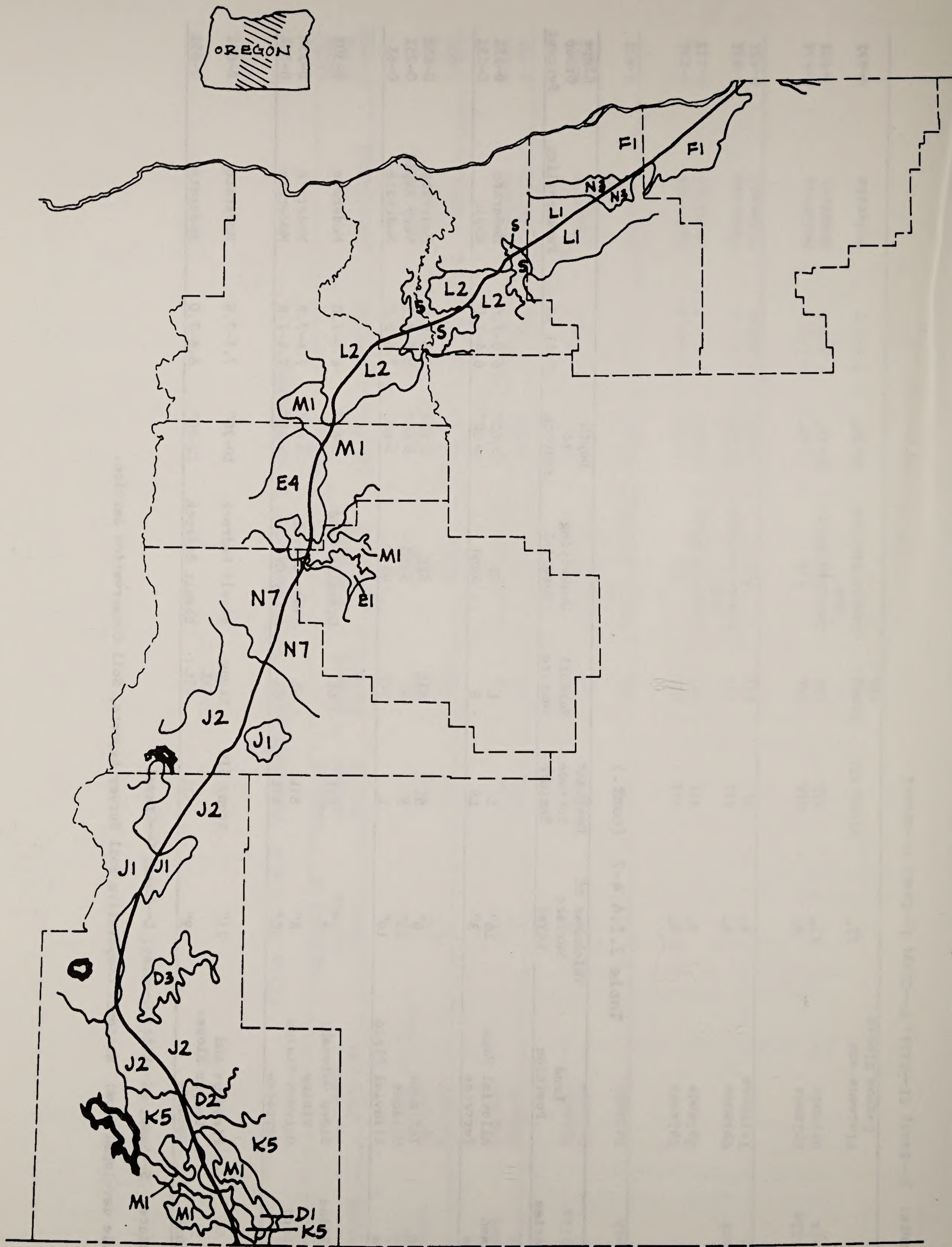
Soil Texture: S--Sand; SI--Silt; C--Clay; L--Loam; G--Gravel

Table 2.1.4.4-2 (cont.)

Soil Series	Land Position	Thickness of Surface Layer	Dominant Surface Texture	Subsoil Texture	Underlying Material	Depth to Bedrock	Soil pH	Permeability	Slope Group Percent
C3									
Garrison	Alluvial Fans	16"	L	L	GS	>60"	6.8-7.6	Moderate	0-15%
Marble	Terraces	3"	LS	S	Sand	>60"	6.4-7.0	Rapid	0-25%
C9									
Warden	Terraces	6"	SL	SIL	SIL	>60"	7.8-8.6	Moderate	0-65%
Quincy	Uplands	15"	S	S	Sand	>60"	8.0-8.2	Very Rapid	0-25%
Naches	Alluvial Plain	10"	L	SCL	GS	>60"	7.6-8.0	Moderate	0-6%
D1									
Hesseltine	Steep Outwash Plains	6"	SIL	GL	Gravelly Sand	>60"	6.5-7.0	Moderate	0-30%
Stratford	Outwash Plains	8"	SIL	GL	Sandy Gravel	>60"	7.6-7.8	Moderate	0-15%
Berge	Terraces	10"	SIL	GL	Sandy Gravel	>60"	7.6-7.8	Moderate	0-30%
F3									
Kuhl	Plateaus and Canyon Slopes	11"	Stony SIL	Stony SIL	Basalt Bedrock	10-20"	7.4-7.6	Moderate	0-65%
Starbuck	Uplands	9"	SIL	SIL	Basalt Bedrock	12-20"	6.6-7.0	Moderate	0-65%

Soil Texture: S--Sand; SI--Silt; C--Clay; L--Loam; G--Gravel

This table developed from: National Cooperative Soil Survey Reports, Soil Conservation Service.



SOURCE: Simonson, G. H., Soil Science Department, Oregon State University, August, 1975.

Figure 2.1.4.4-3 Oregon soil associations

Legend, Figure 2.1.4.4-3 Oregon Soil Associations

I. Soils of Valleys, Basins, and Lowland Plains:

Dark colored grassland soils of eastern intermountain valleys

D1 Dominantly deep, dark colored, nearly level soils of cool, subhumid to semiarid terraces, till plains and floodplains. Poorly drained soils are common.

Light colored shrub-grassland soils of aridic cool and cold, eastern basins and valleys

E1 Dominantly light colored, moderately deep to hardpan, nearly level soils of cool, semiarid to arid basins and valleys

E4 Dominantly light colored, moderately deep to hardpan, loamy soils and deep, sandy, pumice soils of cool, semiarid, gently sloping Central Oregon plains

Light colored, nearly level to sloping shrub-grassland soils of aridic, warm, eastern basins and valleys

F1 Dominantly light colored, sandy soils of the warm, arid, Columbia Basin wind reworked sand deposits

II. Forested Upland Soils:

Soils of the pumice mantled central Oregon plateau and Cascade Mountains

J1 Dominantly light colored, strongly acid, moderately deep, coarse textured pumice soils and shallow rocky soils of cold, humid, higher elevation mountains and buttes

J2 Dominantly light colored, slightly to medium acid, deep and moderately deep, coarse textured pumice soils of cold, subhumid plateaus and buttes

Soils of eastern interior mountains with basic rock types lacking significant volcanic ash deposits

K5 Dominantly dark colored, slightly acid, loamy and clayey, moderately deep soils of cold, subhumid plateaus and mountains. Shallow and stony soils are common.

Legend, Figure 2.1.4.4-3 (cont.) Oregon Soil Associations

III. Dark Colored Soils of Grassland-Steppe Uplands with Moderately Low Rainfall:

Soils of volcanic plateaus and plains with a loess mantle

L1 Dominantly moderately dark colored, deep, silty, gently to strongly sloping soils of warm to cool, semiarid plateaus and rolling hills

L2 Dominantly moderately dark colored, moderately deep to shallow, silty, gently sloping to steep soils of cool, subhumid, dissected plateaus

Soils of hills, mountains and volcanic plateaus without a significant loess mantle

M1 Dominantly dark and moderately dark colored, clayey and loamy, often stony, moderately deep to shallow, soils of cool, subhumid to semiarid, sloping to steep dissected hilly terrain

IV. Light Colored Soils of Shrub-Grassland with Low Rainfall:

Soils of gently sloping plateaus and plains with a loess mantle

N3 Dominantly light colored, deep and moderately deep, silty soils of warm to cool, arid, plateaus and plains

Soils of gently sloping plateaus and plains with eolian sands

N7 Dominantly light colored, moderately deep, sandy pumice soils and shallow, stony soils of the cool, semiarid Central Oregon basalt plateau

V. Miscellaneous Soil Areas and Land Types:

S Dominantly very steep, shallow, stony soils and rock outcrops of canyon lands

Table 2.1.4.4-3 Selected soil characteristics in Oregon

Soil Series	Land Position	Thickness of Surface Layer	Dominant Surface Texture	Subsoil Texture	Underlying Material	Depth to Bedrock	Soil pH	Permeability	Slope Group Percent
F1									
Walla Walla	Upland	8"	SIL	SIL	SIL	> 60"	7.0-8.0	Moderate	0-60%
Quincy	Upland	15"	S	S	Sand	> 60"	8.0-8.2	Very Rapid	0-25%
Onyx	Alluvial Bottom-lands	7"	SIL	SIL	SIL	> 60"	6.1-7.5	Moderate	0-3%
N3									
Ritzville	Upland	9"	SIL	SIL	SIL	> 60"	6.8-8.5	Moderate	0-65%
Warden	Terraces	6"	SL	SIL	SIL	> 60"	7.8-8.6	Moderate	0-65%
L1									
Ritzville	Upland	9"	SIL	SIL	SIL	> 60"	6.8-8.5	Moderate	0-65%
Lickskillet	Upland	6"	L	Stony Loam	Bedrock	< 20"	6.6-7.3	Moderate	0-65%
Wrentham	Upland	6"	L	Stony Loam	Bedrock	20-40"	6.6-7.3	Moderate	0-65%
S									
Lickskillet	Upland	6"	L	Stony Loam	Bedrock	< 20"	6.6-7.3	Moderate	0-65%
Wrentham	Upland	6"	L	Stony Loam	Bedrock	20-40"	6.6-7.3	Moderate	0-65%
L2									
Condon	Upland	6"	SIL	SIL	Bedrock	20-40"	6.6-7.3	Moderate	0-65%
Bakeoven	Upland	6"	L	L	Bedrock	< 20"	6.6-7.3	Moderate	0-65%
M1									
Simas	Upland	6"	CL	SIC	SIC	> 60"	7.3-8.0	Slow	0-65%
Lamonta	Upland	8"	CL	SIC	Hardpan	20-40"	7.3-8.0	Very Slow	0-65%
Powder	Upland	9"	SIL	SICL	SICL	>60"	7.3-8.0	Moderate	0-15%
Lorella	Upland	6"	Stony CL	CL	Hardpan	< 20"	6.6-7.3	Slow	0-25%

Soil Texture: S--Sand; SI--Silt; C--Clay; L--Loam; G--Gravel

Table 2.1.4.4-3 (cont.)

Soil Series	Land Position	Thickness of Surface Layer	Dominant Surface Texture	Subsoil Texture	Underlying Material	Depth to Bedrock	Soil pH	Permeability	Slope Group Percent
E4									
Madras	Upland	8"	SIL	SICL	Hardpan	20-40"	7.3-8.0	Very Slow	0-25%
Agency	Upland	6"	SIL	SICL	Bedrock	20-40"	7.3-8.0	Slow	0-25%
N7									
Gosney	Upland	6"	SL	S	Bedrock	< 20"	6.6-7.3	Rapid	0-65%
Deschutes	Upland	8"	SL	L	Bedrock	20-40"	6.6-7.3	Moderately Rapid	0-15%
J2									
Klawhop	Upland	3"	Ashy	Gravelly Loam	Gravelly Loam	> 60"	6.1-6.6	Moderate	0-65%
Shanahan	Upland	3"	Ashy	SL	SIL	> 60"	6.1-6.6	Moderate	0-65%
J1									
Steiger	Upland	3"	Ashy	Ashy	Ashy	> 60"	6.1-7.3	Rapid	0-65%
K5									
Crume	Upland	8"	CL	CL	Hardpan	40-60"	6.6-7.3	Moderately Slow	0-50%
Woodcock	Upland	3"	L	GL	Bedrock	40-60"	6.1-7.3	Moderate	0-65%
D1									
Stukel	Upland	6"	L	L	Bedrock	< 20"	6.6-7.3	Moderate	0-65%
Fordney	Upland	10"	S	S	Sand	> 60"	6.6-7.3	Very Rapid	0-6%
E1									
Deschutes	Upland	8"	SL	L	Bedrock	20-40"	6.6-7.3	Moderately Rapid	0-15%

Soil Texture: S--Sand; SI--Silt; C--Clay; L--Loam; G--Gravel

This table developed from: National Cooperative Soil Survey Reports, Soil Conservation Service.

Table 2.1.4.4-4 Selected Soil Characteristics in California

Soil Association No. (Map Symbol)	Dominant Soil Series	Subsoil Texture	Soil Reaction in Profile Above 60 Inches 1/	Depth to Hardpan or Bedrock Inches		Permeability 2
				Hard	Rippable	
1	Fordney	Sandy	Neutral	>60	---	Very rapid
1	Poe	Sandy	Strongly alkaline	20-40	---	Moderately rapid
2	Dotta	Fine-loamy	Slightly acid	>60	---	Moderately slow
2	Martineck	Clayey-skeletal	Medium acid	---	< 20	Very slow
2	Bieber	Fine	Slightly acid and neutral	---	< 20	Very slow
3	Portola	Medial	Medium acid	---	20-40	Rapid
3	Lapine	Cindery	Medium acid to neutral	>60	---	Very rapid
3	Gleason	Coarse-loamy	Slightly and medium acid	---	40-60	Moderately rapid
4	Madeline	Clayey	Slightly acid to mildly alkaline	< 20	---	Slow
4	Ninemile	Clayey	Neutral	< 20	---	Very slow
4	Mendebourne	Clayey skeletal	Neutral	20-60	---	Slow
5	Tournquist	Fine-loamy	Slightly acid	20-60	---	Moderate
5	Merlin	Clayey	Neutral	---	< 20	Very slow
5	Aldax	Loamy-skeletal	Neutral	< 20	---	Moderately rapid

Table 2.1.4.4-4 (cont'd.) Selected Soil Characteristics in California

Soil Association No. (Map Symbol)	Dominant Soil Series	Subsoil Texture	Soil Reaction in Profile Above 60 Inches 1/	Depth to Hardpan or Bedrock Inches		Permeability 2/
				Hard	Rippable	
6	Crump	Fine-silty	Neutral and mildly alkaline	> 60	---	Moderate
6	Balman	Fine-loamy	Moderately alkaline	> 60	---	Moderately slow
6	Bunting-ville	Fine-loamy	Mildly and moderately alkaline	> 60	---	Moderately slow
7	Cohasset	Fine-loamy	Slightly to strongly acid	> 60	---	Moderate
7	Windy	Cindery	Strongly acid	20-40	---	Rapid
7	McCarthy	Medial-skeletal	Medium to slightly acid	40-60	---	Rapid
8	Toomes	Loamy	Slightly to medium acid	4-10	---	Moderate
8	Guenoc	Fine	Slightly to medium acid	20-40	---	Moderately slow
8	Supan	Fine-loamy	Mildly alkaline to slightly acid	24-40	---	Moderately slow
9	Tuscan	Fine	Slightly acid	10-20	---	Moderate
9	Inks	Loamy-skeletal	Medium acid	0-20	---	Moderate
10	Toomes	Loamy	Slightly to medium acid	4-10	---	Moderate
10	Guenoc	Fine	Slightly to medium acid	0-40	---	Moderately slow

Table 2.1.4.4-4 (cont'd.) Selected Soil Characteristics in California

Soil Association No. (Map Symbol)	Dominant Soil Series	Subsoil Texture	Soil Reaction in Profile Above 60 Inches 1/	Depth to Hardpan or Bedrock Inches: Hard	Depth to Hardpan or Bedrock Inches: Rippable	Permeability 2/
11	Columbia	Coarse-loamy	Slightly acid to mildly alkaline	> 60	---	Moderate
11	Vina	Fine-loamy	Neutral to mildly alkaline	> 60	---	Moderate
12	Maywood	Coarse-loamy	Slightly acid	> 60	---	Moderate
12	Tehama	Fine-silty	Slightly acid to neutral	> 60	---	Slow
13	Corning	Fine	Strongly to medium acid	> 60	---	Very slow
13	Redding	Fine	Medium to strongly acid	---	8-40	Very slow
14	Newville	Fine	Slightly acid to neutral	> 60	---	Slow
14	Dibble	Fine	Medium acid	---	20-40	Moderately slow
15	Cortina	Loamy-skeletal	Slightly acid to neutral	> 60	---	Very rapid
15	Orland	Fine-loamy	Neutral to mildly alkaline	> 60	---	Moderate
16	Arbuckle	Fine-loamy	Medium acid to neutral	> 60	---	Moderate
16	Kimball	Fine	Slightly acid to mildly alkaline	> 60	---	Very slow

Table 2.1.4.4-4 (cont'd.) Selected Soil Characteristics in California

Soil Association No. (Map Symbol)	Dominant Soil Series	Subsoil Texture	Soil Reaction in Profile Above 60 Inches 1/	Depth to Hardpan or Bedrock Inches: Hard	Depth to Hardpan or Bedrock Inches: Rippable	Permeability 2/
16	Hillgate	Fine	Slightly acid to mildly alkaline	> 60	---	Slow to very slow
17	Hillgate	Fine	Slightly acid to mildly alkaline	> 60	---	Slow to very slow
17	Arbuckle	Fine-loamy	Medium acid to neutral	> 60	---	Moderate
17	Artois	Fine	Slightly acid to mildly alkaline	> 60	---	Slow
18	Myers	Fine	Slightly acid to mildly alkaline	> 60	---	Slow
18	Hillgate	Fine	Slightly acid to mildly alkaline	> 60	---	Slow to very slow
19	Willows	Fine	Slightly acid to strongly alkaline	> 60	---	Very slow
19	Capay	Fine	Slightly acid to moderately alkaline	> 60	---	Very slow
20	Dibble	Fine	Medium acid	---	20-40	Moderately slow
20	Contra Costa	Fine	Neutral	---	20-40	Moderately slow
20	Sehorn	Fine	Neutral	---	20-40	Slow
21	Positas	Fine	Slightly acid to moderately alkaline	> 60	---	Very slow

Table 2.1.4.4-4 (cont'd.) Selected Soil Characteristics in California

Soil Association No. (Map Symbol)	Dominant Soil Series	Subsoil Texture	Soil Reaction in Profile Above 60 Inches 1/	Depth to Hardpan or Bedrock Inches		Permeability 2/
				Hard	Rippable	
21	Perkins	Fine-loamy	Slightly acid and neutral	> 60	---	Moderately slow
21	Newville	Fine	Slightly acid and neutral	> 60	---	Slow
22	Clear Lake	Fine	Neutral and Moderately alkaline	> 60	---	Very slow
22	Sacramento	Very fine	Neutral to moderately alkaline	> 60	---	Slow
22	Willows	Fine	Slightly acid to strongly alkaline	> 60	---	Very slow
23	Yolo	Fine-silty	Neutral and mildly alkaline	> 60	---	Moderately slow
23	Zamora	Fine-silty	Neutral and mildly alkaline	> 60	---	Moderately slow
23	Brentwood	Fine	Mildly or moderately alkaline	> 60	---	Moderately slow
24	Yolo	Fine-silty	Neutral or mildly alkaline	> 60	---	Moderately slow
24	Brentwood	Fine	Mildly to moderately alkaline	> 60	---	Moderately slow
25	Corning	Fine	Strongly to medium acid	> 60	---	Very slow

Table 2.1.4.4-4 (cont'd.) Selected Soil Characteristics in California

Soil Associa-tion No. (Map Symbol)	Dominant Soil Series	Subsoil Texture	Soil Re-action in Profile Above 60 Inches 1/	Depth to Hardpan or Bedrock Inches: Hard	Depth to Hardpan or Bedrock Inches: Rippable	Perme-ability 2/
25	Hillgate	Fine	Slightly acid to mildly alkaline	> 60	---	Slow to very slow
26	Sehorn	Fine	Neutral	---	20-40	Slow
26	Balcom	Fine-loamy	Moderately alkaline	---	12-48	Moderately slow
27	Rincon	Fine	Moderately alkaline	> 60	---	Slow
27	Marvin	Fine	Neutral to moderately alkaline	> 60	---	Slow
27	Tehama	Fine-silty	Slightly acid to moderately alkaline	> 60	---	Slow
28	Tierra	Fine	Medium acid to moderately alkaline	> 60	---	Very slow
28	Antioch	Fine	Medium acid to moderately alkaline	> 60	---	Very slow
28	Milpitas	Fine	Medium acid to mildly alkaline	> 60	---	Very slow
29	San Benito	Fine-loamy	Neutral to moderately alkaline	---	40-60	Moderately slow
29	Diablo	Fine	Mildly and moderately alkaline	---	40-60	Slow

Table 2.1.4.4-4 (cont'd.) Selected Soil Characteristics in California

Soil Association No. (Map Symbol)	Dominant Soil Series	Subsoil Texture	Soil Reaction in Profile Above 60 Inches 1/	Depth to Hardpan or Bedrock Inches		Permeability 2/
				Hard	Rippable	
29	Altamont	Fine	Slightly acid to moderately alkaline	---	40-60	Slow
30	Rindge	Organic	Slightly acid	>60	---	Rapid
30	Venice	Organic	Very strongly acid	>60	---	Rapid

1/ pH:

Extremely acid	<4.5
Very strongly acid	4.5-5.0
Strongly acid	5.1-6.0
Slightly acid	6.1-6.5
Neutral	6.6-7.3
Mildly alkaline	7.4-7.8
Moderately alkaline	7.9-8.4
Strongly alkaline	8.5-9.0
Very strongly alkaline	>9.0

2/ Permeability of least permeable soil layer above 60 inches:

Very slow	<0.06 inches per hour
Slow	0.06-0.2
Moderately slow	0.2-0.6
Moderate	0.6-2.0
Moderately rapid	2.0-6.0
Rapid	6.0-20.0
Very rapid	>20

2.1.4.5 Water Resources

Surface Water

Primary Drainage Basins

Figure 2.1.4.5-1 shows the major water basins in the western United States.

After crossing the international boundary at Eastport, Idaho, the proposed pipeline route follows the Moyie River Valley for about 20 miles and then crosses the Kootenai River upstream from Bonners Ferry, Idaho. It then follows Paradise Valley between the Selkirk and Cabinet Mountains and enters the Pend Oreille River basin. After crossing the Pend Oreille River near Sand Point, Idaho, the route continues in a southwesterly direction, and enters the Spokane River drainage.

After leaving the Idaho-Washington border the route passes through the Spokane, Snake, and Walla Walla River basins, all part of the Columbia River basin. Although the sizes of drainage areas vary widely, the surface-water hydrology of the basins is in many ways similar. All the rivers originate in mountains or highlands where the mean annual precipitation may exceed 50 inches. The rivers then flow westward into the Columbia Plateau, where the precipitation is nearly 10 inches annually. Thus, the rivers show similar annual patterns of runoff with maximum flows usually resulting from snowmelt occurring in May or June in the Kootenai, Pend Oreille, Spokane, and Snake River drainages and about a month or two earlier in the Walla Walla basin. Minimum flows generally occur in late summer or early fall near the end of the low precipitation period.

From the Walla Walla River crossing, the proposed route trends southwestward across the Umatilla, John Day, and Crooked River basins of Oregon. The Umatilla and John Day Rivers drain northward into the Columbia River from high elevations of the Blue Mountains, in Oregon. The Crooked River drains westward into the Deschutes River which flows north into the Columbia River. Precipitation across this area ranges from about 10 inches near the Columbia River to more than 40 inches in the higher parts of the Blue Mountains. Much of the precipitation at the high altitudes of the Blue Mountains occurs as snow. All streams draining the Blue Mountains have similar runoff patterns, with maximum flows occurring from snowmelt in the spring and lowest flows occurring in late summer and early fall.

From the Deschutes River basin, the proposed route traverses southward across a rather flat divide into the Klamath River basin, crossing the Williamson and Sprague Rivers which flow westward into Upper Klamath Lake and are principal headwater tributaries of the Klamath River. Streams in this basin have their maximum flows in winter or early spring, and some are sustained throughout the year by large springs. Precipitation in the Williamson and Sprague River basins ranges from more than 30 inches in headwater areas to about 15 inches in the lower parts. From the Klamath River basin, the pipeline route continues southward into the Lost River basin, crossing the Oregon-California boundary toward the Pit River basin of California.

The part of the Basin and Range province crossed by the proposed route, in northern California, is predominantly young volcanic terrain. Drainage patterns are poorly developed, and the landscape includes numerous marshes and lakes, many of which have undergone shrinkage as a result of both climatic change and local water development. Mean annual precipitation varies from 10 to 18 inches, and mean annual runoff is in the range of 2 to 5 inches.

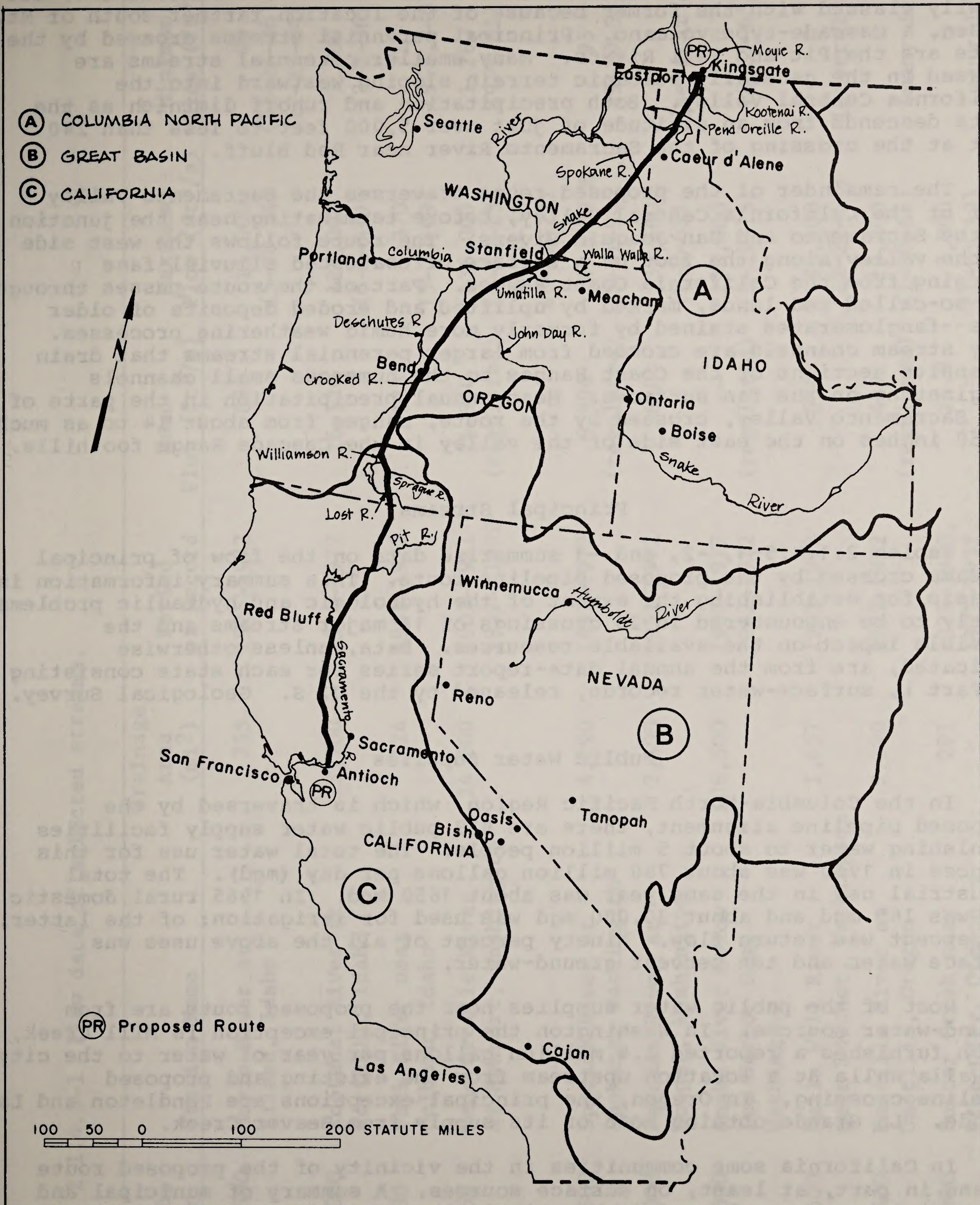


Figure 2.1.4.5-1 Major water basins in the western United States

Continuing southwestward, the proposed route crosses a mountainous area transitional between the Cascade Range and the Sierra Nevada Mountains, but usually classed with the former because of the location farther south of Mt. Lassen, a Cascade-type volcano. Principal perennial streams crossed by the route are the Pit and Fall Rivers. Many smaller perennial streams are crossed in the generally volcanic terrain sloping westward into the California Central Valley. Both precipitation and runoff diminish as the route descends from an altitude of just over 5,000 feet to less than 240 feet at the crossing of the Sacramento River near Red Bluff.

The remainder of the proposed route traverses the Sacramento Valley half of the California Central Valley, before terminating near the junction of the Sacramento and San Joaquin Rivers. The route follows the west side of the valley along the foot of a surface of coalesced alluvial fans emerging from the California Coast Ranges. Part of the route passes through the so-called red lands, marked by uplifted and eroded deposits of older fans--fanglomerates stained by formerly more humid weathering processes. Many stream channels are crossed from larger perennial streams that drain extensive sections of the Coast Ranges to the numerous small channels originating on the fan surfaces. Mean annual precipitation in the parts of the Sacramento Valley, crossed by the route, ranges from about 14 to as much as 50 inches on the east side of the valley in the Cascade Range foothills.

Principal Streams

Tables 2.1.4.5-1, -2, and -3 summarize data on the flow of principal streams crossed by the proposed pipeline route. This summary information is a basis for establishing the extent of the hydrologic and hydraulic problems likely to be encountered in 26 crossings of 18 major streams and the possible impact on the available resources. Data, unless otherwise indicated, are from the annual data-report series for each state consisting of Part 1, surface-water records, released by the U. S. Geological Survey.

Public Water Supplies

In the Columbia-North Pacific Region, which is traversed by the proposed pipeline alignment, there are 829 public water supply facilities furnishing water to about 5 million people. The total water use for this purpose in 1960 was about 780 million gallons per day (mgd). The total industrial use in the same year was about 1650 mgd. In 1965 rural domestic use was 185 mgd and about 30,000 mgd was used for irrigation; of the latter, 54 percent was return flow. Ninety percent of all the above uses was surface water and ten percent ground-water.

Most of the public water supplies near the proposed route are from ground-water sources. In Washington the principal exception is Mill Creek, which furnishes a reported 1.4 million gallons per year of water to the city of Walla Walla at a location upstream from the existing and proposed pipeline crossing. In Oregon, the principal exceptions are Pendleton and La Grande. La Grande obtains most of its supply from Beaver Creek.

In California some communities in the vicinity of the proposed route depend in part, at least, on surface sources. A summary of municipal and industrial water supplies for the principal metropolitan areas follows.

The Vallejo-Napa metropolitan area comprises an area of 1585 sq. mi. and a population of 239,000. The municipal and industrial water supplies of Napa and Solano Counties are obtained from local surface water and ground-water sources or by diversion from Cache Slough.

Table 2.1.4.5-1 Flow data of selected streams.

Station Number	Station Name	Drainage Area (mi^2)	Period of Record	Mean Flow (ft^3/s)	Maximum Flow (ft^3/s)	Minimum Flow (ft^3/s)
12307500	Moyie River at Eileen, Idaho	755	1925-1972	888	11,000 (5-20-54)	40 (11-27-36 and 12-17-64)
12322000	Kootenai River at Porthill, Idaho	13,700	1928-1972	16,120	125,000 (6-1-48)	1,380 (2-8-36)
1239230	Pack River near Colburn, Idaho	124	1958-1972	333	4,370 (5-30-69)	15 (9-2,3-67)
1239550	Pend Oreille River at Newport, Washington	24,200	1903-1941 1952- 1972	24,990 (regulated)	136,000 (6-15-13, 6-21-33, &6-12-72)	1,280 (9-1-61)
12422500	Spokane River at Spokane, Washington	4,290	1891-1972	6,904 (regulated)	49,000 E (5-31-94)	95 (9-19-56)
13351000	Palouse River at Hooper, Washington	2,500	1951-1972	610	33,500 (2-4-63)	0 (several days)
13353000	Snake River below Ice Harbor Dam, Washington	108,500	1907-1917 1962-1972	-- (regulated)	298,000 (5-29-13)	0 (8-27-65)
14018500	Walla Wall River near Touchet, Washington	1,657	1951-1972	584	33,400 (12-22-64)	0 (several days)
14033500	Umatilla River at Umatilla, Oregon	2,290	1927-1972	437 (regulated)	19,800 (1-30-65)	0 (many days)
14032000	Butter Creek near Pine City, Oregon	291	1929-1930, 1931-1932, 1933-1941, 1942-1972	24.9	3,800 (1-21-49)	0 (many days)

Table 2.1.4.5-1 (cont.)

Station Number	Station Name	Drainage Area (mi^2)	Period of Record	Mean Flow (ft^3/s)	Maximum Flow (ft^3/s)	Minimum Flow (ft^3/s)
14034500	Willow Creek at Heppner, Oregon	87	1951-1972	18.6	812 (5-10-57)	0 (many days)
14046500	John Day River at Service Creek, Oregon	5,090	1925-1926, 1929-1972	1,819	40,200 (1-23-64)	20 (10-6-31)
14048000	John Day River at McDonald, Oregon	7,580	1904-1972	2,006	42,800 (1-24-64)	0 (9-2-66)
14087300	Crooked River near Terrebonne, Oregon	4,240	1967-1972	362 (regulated)	4,060 (1-20-71)	10 (8-8-70)
11493599	Williamson River near Klamath Agency, Oregon	1,290	1908-1910 1954-1972	213	1,590 (1-13-10)	0 (many days)
11501000	Sprague River near Chiloquin, Oregon	1,580	1921-1972	574	14,900 (12-26-64)	50 (5-26,27-26)
11353700	Fall River near Dana, California	123	1958-1967	460	3,910 (12-23-64)	353 (1-29-62)
11377100	Sacramento River near Red Bluff, California	8,900	1879-1972	11,650 (regulated)	291,000 (2-28-40)	2,000 (3-29-44)
11388000	Stony Creek below Black Butte Dam, near Orland, California	737	1955-1972	-- (regulated)	36,300 (2-24-58)	0 (many days)
11390672	Stone Corral Creek near Sites, California	38.2	1958-1972	5.3	2,640 (1-29-68)	0 (many days)
11452000	Cache Creek near Capay, California	1,044	1942-1972	643 (regulated)	51,600 (2-24-58)	0 (many days in 1972)

Estimated

Table 2.1.4.5-2 Floods of selected recurrence intervals for selected streams (written communication, U.S. Geological survey, 1974).

Station Number	Station Name	Discharge (ft^3/s)	Recurrence Intervals (yrs)
12307500	Moyie River at Eileen, Idaho	11,400	200
		11,000	100
		10,700	50
1422500	Spokane River at Spokane, Washington	48,900	200
		46,600	100
		44,000	50
13351000	Palouse River at Hooper, Washington	42,000	200
		36,900	100
		31,900	50
14018500	Walla Walla River near Touchet, Washington	63,400	200
		48,400	100
		36,400	50
14034500	Willow Creek at Heppner, Oregon	--	200
		35,000	100
		14,000	50
14046500	John Day River at Service Creek, Oregon	51,000	200
		44,000	100
		37,000	50
1404800	John Day River at McDonald Ferry, Oregon	47,000	200
		41,000	100
		35,000	50
11502500	Williamson River below Sprague River near Chiloquin, Oregon	17,000	200
		14,000	100
		11,000	50
11501000	Sprague River near Chiloquin, Oregon	17,000	200
		13,000	100
		10,000	50
11388000	Stony Creek below Black Butte Dam near Orland, California	54,800	200
		45,300	100
		36,500	50
1145200	Cache Creek near Capay, California	76,900	200
		65,900	100
		55,400	50

Table 2.1.4.5-3 Flow duration for selected stations (U.S. Geological Survey, written communication, 1974).

Station Number	Station Name	Years of Record	Discharge in ft^3/s equaled or exceeded a given percent of time: 99%	90%	70%	50%	30%	10%	1%
12395500	Pend Oreille River at Newport, Washington	1904-12, 1929-41, 1953-62	4,830	7,500	10,900	15,700	25,100	59,200	98,800
12422500	Spokane River at Spokane, Washington	1892-1972	950	1,540	2,210	3,790	7,830	17,900	29,800
13351000	Palouse River at Hooper, Washington	1952-1972	1.6	26	73	188	571	1,660	5,690
13353000	Snake River below Ice Harbor Dam, Washington	1963-1972	15,500	22,000	29,200	37,300	57,900	126,000	199,000
14018500	Walla Walla River near Touchet, Washington	1952-1972	4.2	14	36	326	722	1,470	3,780
14033500	Umatilla River near Umatilla, Oregon	1943-1972	0.4	10	37	135	410	1,400	4,000
14034500	Willow Creek near Heppner, Oregon	1953-1972	0	0.2	2.0	6.5	20	50	140

Table 2.1.4.5-3 (cont.)

Station Number	Station Name	Years of Record	Discharge in ft^3/s equaled or exceeded a given percent of time						
			99%	90%	70%	50%	30%	10%	1%
14046500	John Day River at Service Creek, Oregon	1931-1972	37	115	325	690	2,000	5,000	11,000
14048000	John Day River at McDonald Ferry, Oregon	1906-1972	33	135	370	710	2,100	5,700	12,000
14087300	Crooked River near Terrebone, Oregon	1969-1972	26	77	125	190	290	850	2,600
11493500	Williamson River near Klamath Agency, Oregon	1955-1972	0	0	30	140	290	550	1,000
11501000	Sprague River near Chiloquin, Oregon	1922-1972	140	205	270	340	510	1,250	3,400
11377100	Sacramento River near Red Bluff, California	1969-1972	6,100	7,200	8,900	11,000	14,000	21,000	77,000
11388000	Stony Creek below Black Butte Dam near Orland, California	1955-1972	0	17	75	140	300	700	6,400

Table 2.1.4.5-3 (cont.)

Station Number	Station Name	Years of Record	Discharge in ft^3/s equaled or exceeded a given percent of time						
			99%	90%	70%	50%	30%	10%	1%
11390672	Stone Corral Creek near Sites, California	1958-1972	0	0	0	0.1	0.4	4.7	130
11452000	Cache Creek near Capay, California	1942-1972	2.9	20	130	300	430	990	6,900

The Sacramento metropolitan area comprises an area of 3,441 sq. mi. and a population of 737,000. Most of the city of Sacramento and some of the suburban areas are supplied with water from the Sacramento River, but the remainder of the city and much of the suburban territory obtain water from wells tapping alluvial deposits. Roseville, and smaller nearby cities, use water from the Yuba and Bear Rivers.

The San Francisco-Oakland metropolitan area comprises an area of 2,486 sq. mi. and a population of 2,918,000. The municipal and industrial water supplies for San Francisco and other communities on the San Francisco peninsula are principally from the Hetch Hetchy Aqueduct, which brings water from the Tuolumne River in the Sierra Nevada. The East Bay MUD system supplies water from the Mokelumne River to Oakland, Richmond, Alameda, and other communities north of Hayward on the east side of San Francisco Bay. Fremont and Newark depend primarily upon wells and local stream supplies. Marin County communities obtain their supplies largely from local streams.

Water Quality

Table 2.1.4.5-4 summarizes selected data on sediment concentration and sediment discharge. Tables 2.1.4.5-5 and -6 summarize selected information as to the chemical, physical, biochemical, and biologic quality of streams crossed by the proposed route. The tables are, in terms of maximum and minimum values, generally over intervals of a year for streamflow, bicarbonate, sulfate, chloride, hardness, specific conductance, dissolved solids, pH, turbidity, temperature, total nitrogen, total phosphorous, dissolved oxygen, biochemical oxygen demand, and coliform bacteria count. Most of the parameters listed are readily measurable. Among them, any future substantial deviation from the listed maximum and minimum values would signify a notable impact on the quality of the stream waters. Water suitable for drinking and for most other uses should not exceed the following:

Dissolved solids, 500 to 1000 mg/l;
Chlorides, 250 mg/l;
Sulfate, 250 mg/l;
Nitrogen (NO_3), 10 mg/l;
Barium, 1 mg/l;
Cadmium, 0.01 mg/l;
Chromium, 0.05 mg/l;
Copper, 1 mg/l;
Iron, 0.3 mg/l;
Lead, 0.05 mg/l;
Manganese, 0.5 mg/l;
Selenium, 0.01 mg/l;
Silver, 0.05 mg/l;
Zinc, 5 mg/l.

Dissolved oxygen content necessary for the support of fish and other aquatic life should be more than 5 mg/l.

Data in Tables 2.1.4.5-4, -5, and -6 are from the annual data report series for each state consisting of Part 2, water-quality records, released by the U. S. Geological Survey.

Table 2.1.4.5-4 Suspended-sediment data for selected streams.

Station	Drainage Area (sq. mi.)	Sampling Frequency	Period of Record	Sediment Concentration Maximum daily (mg/1)	Sediment Concentration Minimum daily (mg/1)	Sediment Discharge Maximum daily (tons)	Sediment Discharge Minimum daily (tons)
Kootenai River near Copeland, ID	13,400	D	1966-1972	740 (5-1-66)	1 (many days)	155,000 (5-1-65)	5 (1-31-72)
Palouse River at Hooper, WA	2,500	D	1961-1971	46,000 (2-5-63)	No flow (several days)	2,100,000 (2-5-63)	No flow (several days)
Walla Walla near Touchet, WA	1,657	D	1962-1970	61,200 (2-5-63)	No flow (several days)	3,230,000 (12-23-64)	No flow (several days)
Umatilla River near Umatilla, OR	2,290	D	1962-1970	39,800 (7-27-65)	1 (several days)	438,000 (1-30-65)	less than 0.005 (4-15,16-68)
Willow Creek near Arlington, OR	850	D	1962-1970	97,600 (6-10-69)	No flow (many days)	980,000 (12-22-64)	No flow (many days)
John Day River at McDonald Ferry, OR	7,580	D	1962-1970	69,200 (12-22-64)	1 (several days)	3,800,000 (12-22-64)	0.11 (8-7-68)
Sacramento River at Bend, CA	8,904	D	1957-1970	3,470 (1-24-70)	1 (many days)	1,200,000 (1-24-70)	12 (several days)
Thomas Creek at Paskenta, CA	194	D	1962-1972	60,200 (12-22-64)	No flow (10-4-64)	5,070,000 (12-22-64)	No flow (many days)
Cache Creek at Yolo, CA	1,139	P-D	1958-1965 1966-1967	7,520 (1-6-65)	No flow (many days)	593,000 (1-6-65)	No flow (many days)

D--Daily Sampling. P--Periodic Sampling.

Table 2.1.4.5-5 Summary of water quality data for selected surface waters crossed in the proposed pipeline route

	Discharge (ft^3/s)	Bicarbonate (HCO_3) mg/l	Sulfate (SO_4) mg/l	Chloride (Cl) mg/l	Hardness (Ca,Mg) mg/l	Specific cond. µmhos 25°C	Diss. solids (180°C) mg/l	pH units	Turbidity units	Temperature °C	Total Nitrogen (N) mg/l	Total Phosphorus (P) mg/l	Diss. Oxygen (DO) mg/l	Biooxygen demand (BOD) mg/l	Imm. coliform Col/100 ml
Kootenai River near Copeland, Idaho; October 1971 to June 1972															
Max.	47,600	149	31	4.0	150	311		8.3	30	9.5	0.67	.15	13.7	1.8	380
Min.	2,840	66	7.1	.4	65	137		6.0	1	0	.08	.03	11.4	.1	12
Kootenai River at Leonia, Idaho; October 1971 to June 1972															
Max.		151	33	5.1	160	314		8.2	30	19	2.3	.18	14.5	2.5	1,100
Min.		78	3.3	.7	74	133		6.4	1	0	.11	.03	10.1	.6	17
Spokane River at Spokane, Washington; October 1972 to September 1973															
Max.	6,880		12		85	260		8.2	6	18.4	.41	.20	14.0	15.0	>4,000
Min.	385		7.7		27	70		6.8	0	1.7	.08	.00	9.1	.5	100
Hangman Creek at Mouth at Spokane, Washington; October 1972 to September 1973															
Max.	400		24		170	440		8.7	1,300	21.2	7.8	1.8	14.6	4.6	47,000
Min.	1.6		7.1		37	110		7.2	0	.6	.16	.01	9.9	.4	180
Snake River near Clarkston, Washington; October 1971 to September 1972															
Max.	208,000	171	51	17	152	441		8.1	50	14.5	.64	.27	13.7	4.4	
Min.	31,900	20	2.9	.1	12	57		6.4	2	2	.14	.04	10.8	1.4	
Palouse River at Hooper, Washington; December 1970 to September 1971															
Max.	1,690					400		8.9	170	29.5	1.1	.59	13.4		
Min.	26					146		7.2	8	2.4	.07	.10	8.2		
Touchet River at Touchet, Washington; October 1971 to September 1972															
Max.	2,550	259	16	15	180	507		8.0	1,400	29.9	4.3	.75	13.2		30,000
Min.	6.6	29	2.0	1.9	23	61		7.2	1	.0	.10	.090	6.0		100
John Day River at McDonald Ferry, Oregon; October 1961 to July 1962															
Max.	2,820	192	14	4.8	132	330	203	8.8	350						
Min.	105	72	4	.5	52	124	98	7.2	0						
Pit River near Canby, California; Sta. No. 11348500, October 1970 to September 1971															
Max.	3,660	154	8.1	9.0	90	289	180	8.1	160	24					
Min.	76	73	6.6	1.7	46	142	119	7.3	25	.0					
Sacramento River at Ben, California; Sta. No. 11377200, November 1970 to September 1971															
Max.	15,800	63		5.2	49	127		8.3							
Min.	7,600	55	5.6	2.6	38	109		7.0							

Table 2.1.4.5-6 Characteristics of rivers in major basins crossed by the proposed route.

River	Average Discharge cu. ft./sec.	Flow and Depth Classification	Bottom Characteristics	Water Quality Rating
Moyie	888	Swift, shallow	Gravel	Excellent
Kootenai	N.R.	Sluggish, deep	Mud and silt	Excellent
Pend Oreille	333	Variable (fed by lakes	Sand and gravel	Excellent
Spokane	6,904	Swift, shallow	Rock rubble	
Palouse	610	Sluggish, moderate	Soft mud	Good
Snake	37,300	Sluggish, deep	Soft mud	Good
Walla Walla	584	Swift, shallow	Firm	Seasonally variable
Umatilla	437	Seasonally variable	Mud or sand	Good
John Day	2,006	Seasonally variable	Mud or sand	Fair to good
Crooked	362	N.R.	N.R.	N.R.
Williamson	213	N.R.	N.R.	N.R.
Sprague	574	N.R.	N.R.	N.R.
Lost	-	N.R.	N.R.	N.R.
Pit	460	(crossing located at Lake Britton)		Excellent
Sacramento	11,650	Tidal	Mud	Poor
San Joaquin	-	Tidal	Mud	Poor

N.R.--No records available at pertinent site.

Chemical Quality

In the region, traversed by the first 500 miles of the proposed route, surface water is generally chemically suited for domestic use by man and for most industries, with various degrees of pre-treatment. Specifically, most of the surface water in lowland areas of the Northern Rocky Mountain Province and the Pacific Northwest Region is low in dissolved-solids content. Generally they contain less than 250 mg/l (milligrams per liter) of dissolved-solids, and commonly less than 100 mg/l. The greater concentrations prevail during periods of low flow derived chiefly from groundwater. Most of the water is moderately hard (61-120 mg/l as $CaCO_3$) or hard (121 to 180 mg/l as $CaCO_3$).

In mountainous parts of the Pacific Northwest, surface water generally has a dissolved-solids content less than 100 mg/l and some less than 50 mg/l. Certain lakes with no surface outlet have a dissolved-solids content ranging from 1,000 mg/l to 70,000 mg/l or more, depending on the amount of water inflow and other factors. The chemical composition of the dissolved-solids varies according to the environment of the particular drainage basin. The principal constituents are generally calcium, magnesium, and bicarbonate, but in some streams, tributary to the Snake River, they are sodium and bicarbonate. Because most of the streams contain dissolved oxygen in concentrations more than 7.0 mg/l, inorganic iron in solution is less than 0.2 mg/l. Irrigation return flow increases the dissolved-solids content of the receiving waters, and thereby decreases the quality of these waters.

In addition to irrigation return flows, natural solvent action, and in places, spring inflow, contribute to downstream increases in dissolved-solids content of streams flowing through arid parts of the region. This is illustrated in a general way by Figures 2.1.4.5-2 and -3.

Biological - Biochemical Quality

At most areas in the Pacific Northwest the biological quality of surface-water is excellent. However, in the general area of the proposed route, local occurrences of bacteriological pollution--maximum most-probable-number (MPN)--values greater than 10,000 coliform-bacteria colonies per 100 milliliters--occur in the Snake River, Pend Oreille River, and Spokane River. These maximum values usually occur during the summer when streamflow is low.

In most streams of the Pacific Northwest the dissolved oxygen concentration is considerably more than the minimum essential for the maintenance of a high diversity of aquatic life in a stream. Some areas of considerable dissolved-oxygen deficiency do occur but usually they are confined to short reaches of streams that receive oxygen-consuming wastes from industries and from cities.

Aquatic biology and related flow data were obtained from "Environmental Data Statement, A Natural Gas Pipeline, Nevada-California Border to Cajon, California. (Woodward-Envicon, Inc., Appendix V, Nov. 15, 1974.)

Temperature

Stream temperatures in the Pacific Northwest rarely exceed 27°C even after the water has been used by man. The headwater reaches of streams generally contain the colder water.

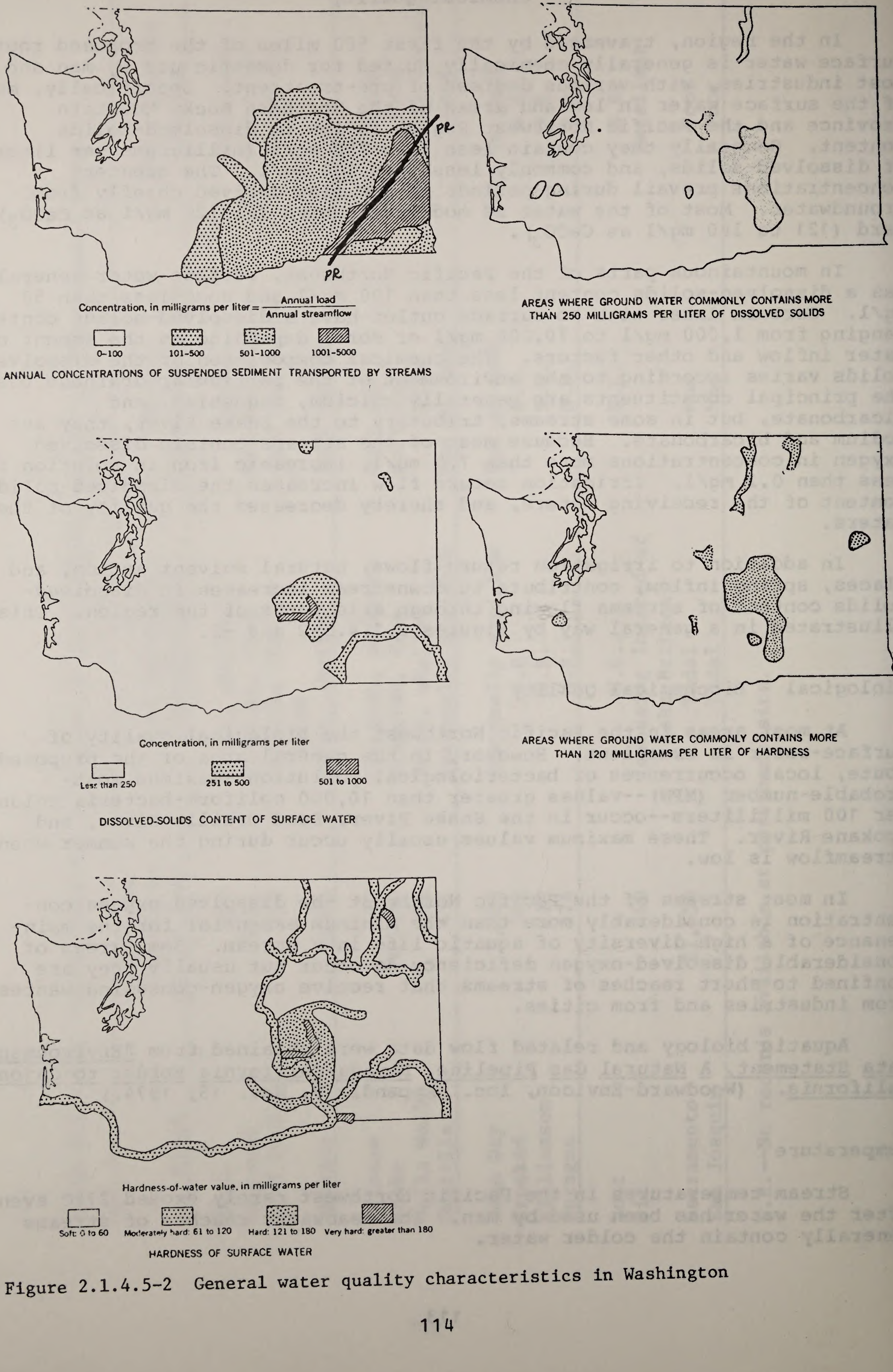


Figure 2.1.4.5-2 General water quality characteristics in Washington

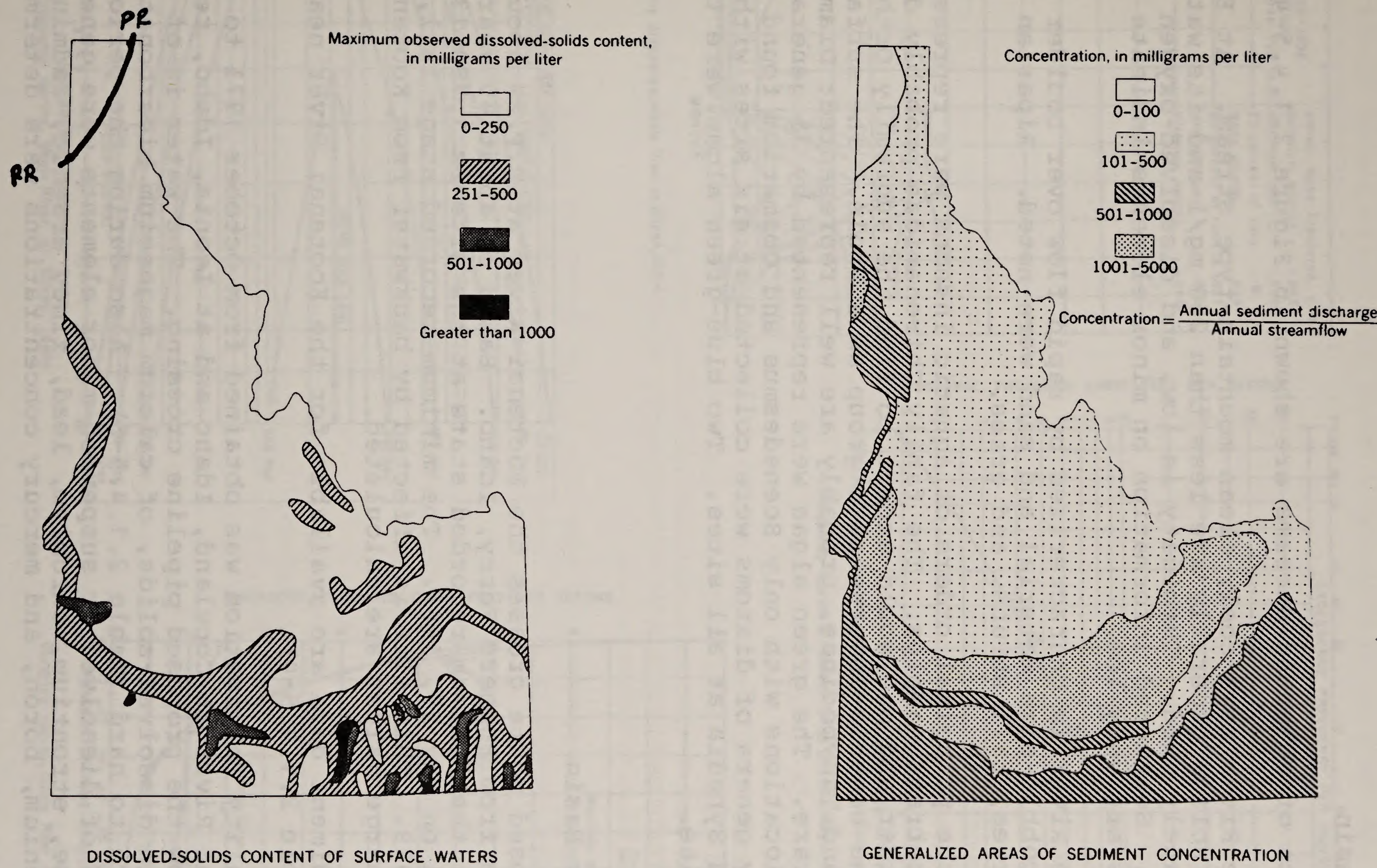


Figure 2.1.4.5-3 Dissolved solids and suspended-sediment concentration in surface waters of Idaho

Particular Features of the Several River Basins

The drainage areas of major rivers which the pipeline will cross are shown in Figure 2.1.4.5-1.

Moyie River Basin

Flood data of selected streams are shown in Figure 2.1.4.5-4.

The Moyie River is a cool, clean mountain-type stream. At Eastport, its dissolved solids generally are less than 200 mg/l and its waters are soft to moderately hard. Turbidity is low, and dissolved-oxygen values exceed 9 mg/l. Scattered information on minor elements indicate these concentrations are very low.

The Moyie River is characterized by rapid flow over boulder gravel. Some smaller cobble-size material and sand were noted. Riparian vegetation consists of trees, tall shrubs, and grass.

Most of the principal orders of aquatic insects were represented in the benthic invertebrate samples. The family Chironamidae probably dominates the Diptera order and one would expect to find the subfamily Orthocladiinae to dominate the benthic-invertebrate group as a whole. The subfamilies, Chironominae and Tanypodinae, probably are well represented; Diamesinae probably are rare. The green algae were represented by 15 genera in samples taken at six locations with only Scenedesmus and Cosmarium found at all six sites. Twenty genera of diatoms were collected at six sites with only Tabellaria and Synedia at all sites. Two blue-green algae were taken, each at a single site.

Kootenai River Basin

The proposed route crosses the Kootenai River at M.P.24 about three miles upstream from Bonners Ferry, Idaho. Based on about 45 years of gauge-height record, the maximum recorded state at the site is 1,780.13 ft. above mean sea level on May 29, 1961. The minimum recorded stage is 1,741.14 on December 5, 1929. This site is affected by backwater from Kootenai Lake and no water discharge values are calculated.

Daily sediment data are available for the Kootenai River near Copeland from 1966 (Table 2.1.4.5-4).

Water quality information was obtained from October 1971 to June 1972 on the Kootenai River at Copeland, Idaho and at Leonia, Idaho, respectively, above and below the proposed pipeline crossing. The water is of excellent quality, low in dissolved-solids, of calcium magnesium bicarbonate type, and moderately hard to hard (Table 2.1.4.5-5). Also during the period, concentrations of dissolved or suspended minor elements were generally low. Iron, manganese, strontium, chromium, lead, zinc, arsenic, cadmium, vanadium, selenium, boron, and mercury concentrations were determined in the analyses.

Water temperatures at the Copeland site for the period of record, 1966 to 1972, ranged from a high of 22.0°C in the summer to 0°C on many days during December, January, and February of most years. Maximum water temperature at the Leonia station for the period of record, 1965 to 1972, was 24.5°C.

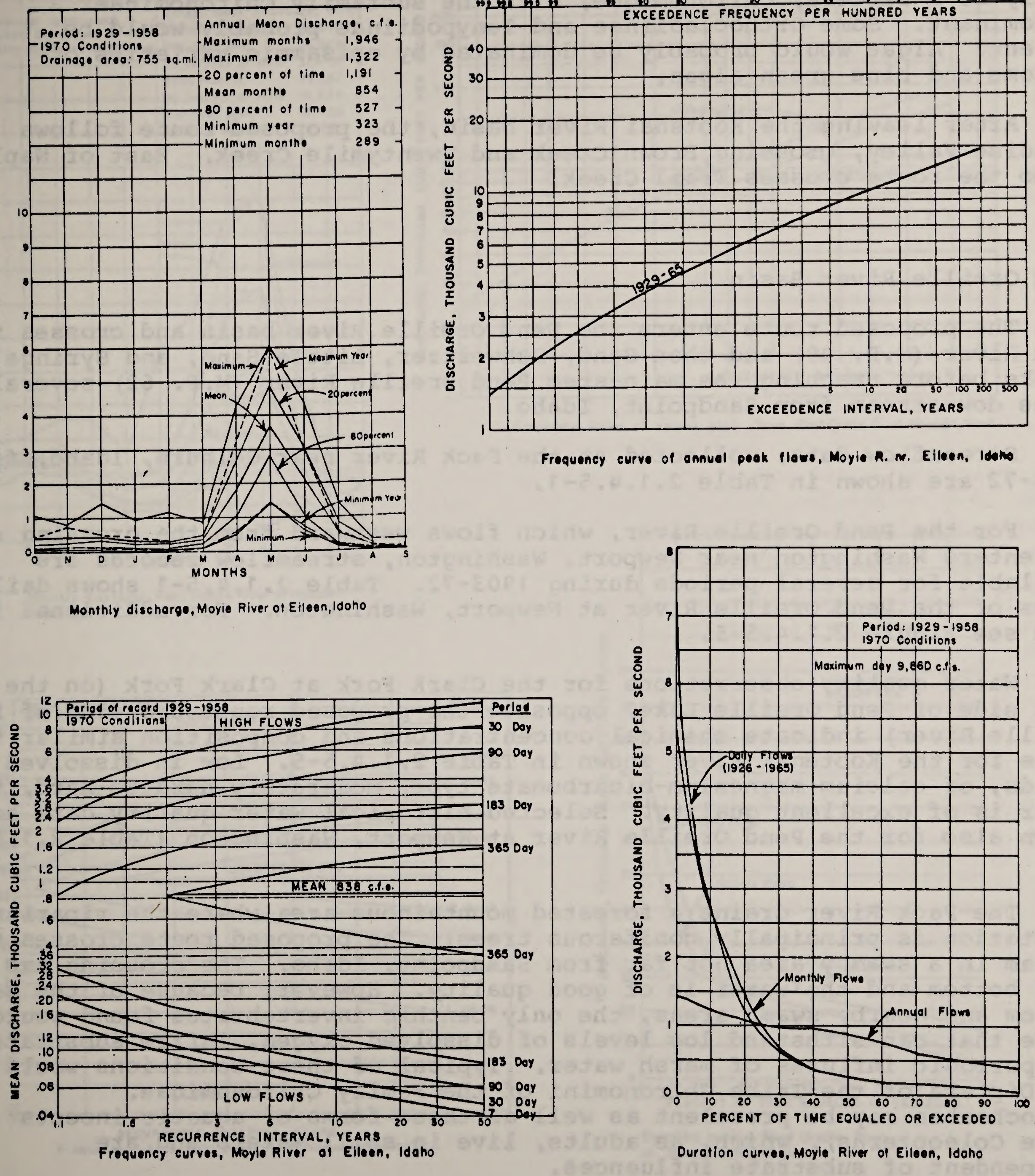


Figure 2.1.4.5-4 Streamflow characteristics of the Moyie river at Eileen, Idaho

Dissolved oxygen is high and approaches saturation. Seasonal variations occur during spring and early summer when oxygen demands in the river increase.

Characteristically, the river is sluggish and its bottom is composed of mud and silt. In such an environment benthic invertebrates would most likely be a Diptera, Chironomidae, with the subfamily Chironominae predominant. Some Orthocladiinae and Tanypodiinae probably would be present. Algae would probably be dominated by episammic varieties of diatoms and blue-green algae.

After leaving the Kootenai River basin, the proposed route follows Paradise Valley, crossing Brown Creek and Twentymile Creek. East of Naples, Idaho the route crosses Trail Creek.

Pend Oreille River Basin

The proposed route enters the Pend Oreille River basin and crosses the Pack River (M.P. 48) and then Sand, Schweitzer, Little Sand, and Syringa Creeks before reaching the main-stem Pend Oreille River (M.P. 62) several miles downstream from Sandpoint, Idaho.

Streamflow data, collected at the Pack River near Colburn, Idaho, from 1958-72 are shown in Table 2.1.4.5-1.

For the Pend Oreille River, which flows westward from the crossing site and enters Washington near Newport, Washington, streamflow records are available for several periods during 1903-72. Table 2.1.4.5-1 shows daily flows of the Pend Oreille River at Newport, Washington. For additional flow data see Figure 2.1.4.5-5.

Water quality observations for the Clark Fork at Clark Fork (on the east side of Pend Oreille Lake, opposite the proposed route crossing of Pend Oreille River) indicate chemical concentrations and composition similar to those for the Kootenai River shown in Table 2.1.4.5-5. Low in dissolved solids, of calcium-magnesium-bicarbonate type, moderately hard to hard, the water is of excellent quality. Selected historical water quality data are shown also for the Pend Oreille River at Newport, Washington (Table 2.1.4.5-6).

The Pack River drains a forested mountainous area where the riparian vegetation is principally coniferous trees. The proposed route crosses the stream in a swampy area not far from Sandpoint, Idaho. The crossing has a sand bottom and the water is of good quality. However, because of the sand bottom and nearby swamp areas, the only benthic invertebrates found would be those that can withstand low levels of dissolved oxygen, infirm substrate and periodic influxes of marsh water. Typical of these conditions would be the Diptera of the Tribe Chironomini of the Family Chironomidae. Oligochaetes may be prevalent as well as those forms of aquatic insects (some Coleopteras), which, as adults, live in still waters and are independent of substrate influences.

Sampling of biota revealed high quality water in those smaller streams in the Pend Oreille River and Pack River drainage basins where flow was rapid and substrate firm. Sand Creek (three sites), Schweitzer Creek, Little Sand Creek (three sites), No Name Creek, Syringa Creek (three sites), and Butler Creek had these characteristics. Typical benthic invertebrates taken in these streams were Plecoptera, Tricoptera, Ephemeroptera, Diptera, and Coleoptera. Cocolalla Creek (three sites) and Westmond Creek (one site)

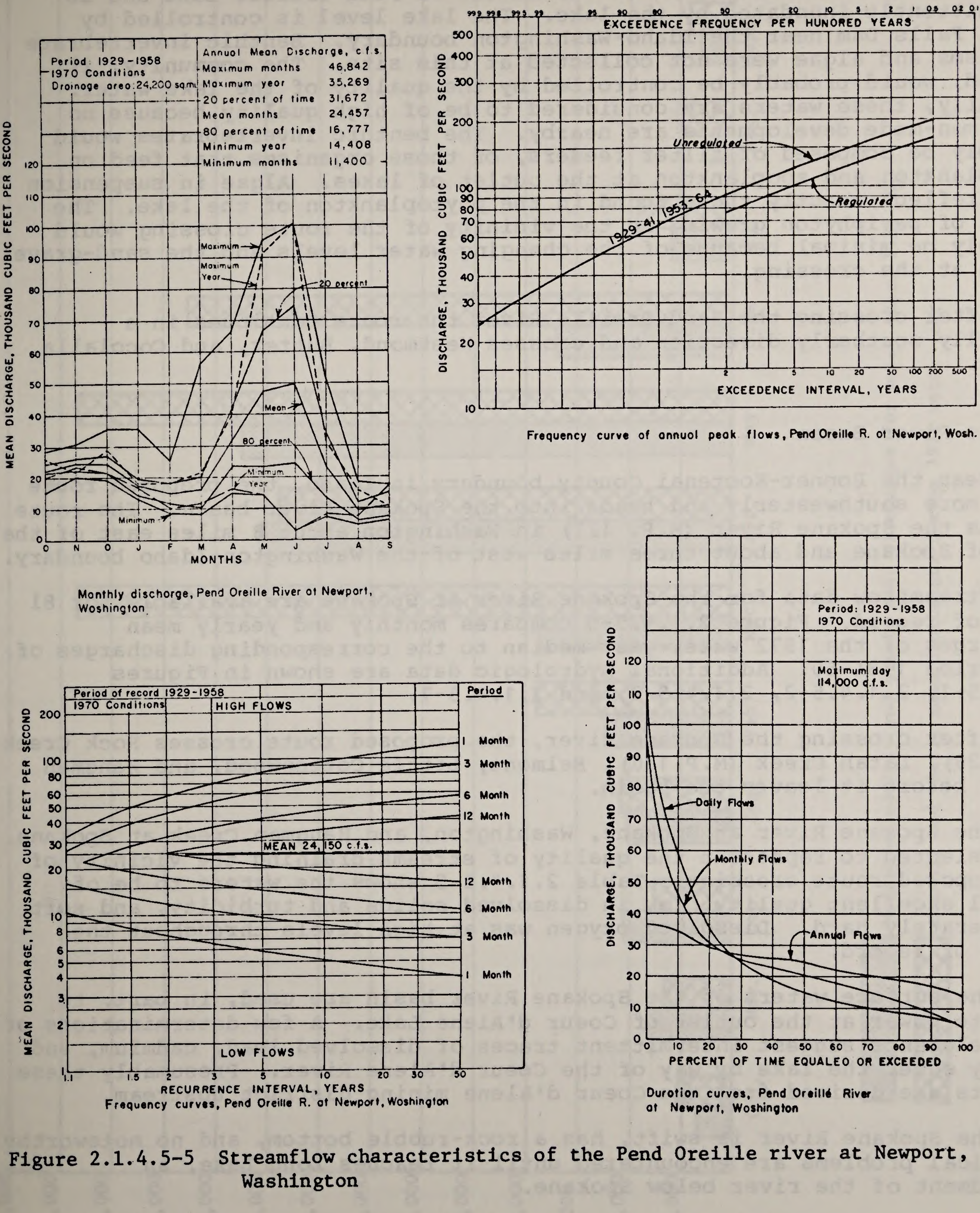


Figure 2.1.4.5-5 Streamflow characteristics of the Pend Oreille river at Newport, Washington

were sluggish and had fine sand to muck bottoms with the benthic groups dominated by Diptera (probably in the Chironomini of the Chironomidae) and Oligochaetes.

The proposed crossing is at the outlet of Pend Oreille Lake and is intermittently inundated by the lake. The lake level is controlled by Albeni Falls Dam near the Idaho-Washington boundary. Benthic invertebrate organisms and algae were not collected at this site. The community, if sampled, would probably be controlled by the quality of the lake water. Generally, these waters are considered to be of high quality because no large man-made developments are nearby. The benthic invertebrates would probably be composed of filter feeders, or those organisms that feed on phytoplankton and zooplankton at the outlet of lakes. Algae in suspension would reflect exactly those found in the phytoplankton of the lake. The amount of periphyton growing in the vicinity of the route crossing would probably be minimal because of the changing water levels and the sand-gravel bottom at the crossing.

After crossing the Pend Oreille River the route continues in a generally southerly direction and crosses Westmond, Butter, and Cocolalla Creeks.

Spokane River Basin

Near the Bonner-Kootenai County boundary in Idaho, the proposed route turns more southwesterly and heads into the Spokane River basin. The route crosses the Spokane River (M.P. 111) in Washington about 8 miles east of the city of Spokane and about three miles west of the Washington-Idaho boundary.

Streamflow data for the Spokane River at Spokane are available for 81 years of record. Figure 2.1.4.5-6 compares monthly and yearly mean discharges of the 1972 water-year median to the corresponding discharges of the period 1931-60. Additional hydrologic data are shown in Figures 2.1.4.5-1, 2.1.4.5-2, 2.1.4.5-3, and 2.1.4.5-7.

After crossing the Spokane River, the proposed route crosses Rock Creek (M.P.126), Latah Creek (M.P.130), Belmont, Little Cottonwood, and Hangman Creeks before it leaves the basin.

The Spokane River at Spokane, Washington, and Hangman Creek at Spokane, were selected to represent the quality of streams draining the vicinity of the proposed route crossing. Table 2.1.4.5-5 shows the waters to be of overall excellent quality, low in dissolved solids and turbidity, and soft to moderately hard. Dissolved oxygen was at high levels throughout the period of record.

The surface waters of the Spokane River basin are used, in part, to generate power at the outlet of Coeur d'Alene Lake. A few determinations of minor elements suggest intermittent traces of dissolved lead, cadmium, and mercury enter the lake by way of the Coeur d'Alene River. Presumably these elements are derived from the Coeur d'Alene mining district upstream.

The Spokane River is swift, has a rock-rubble bottom, and no noteworthy biological problems are encountered until it reaches Long Lake, an impoundment of the river below Spokane.

Two tributaries to the Spokane River, which will be crossed by the proposed route, Hangman Creek and Rock Creek, were sampled for benthic invertebrates. The relatively high numbers of Diptera suggest an enriched

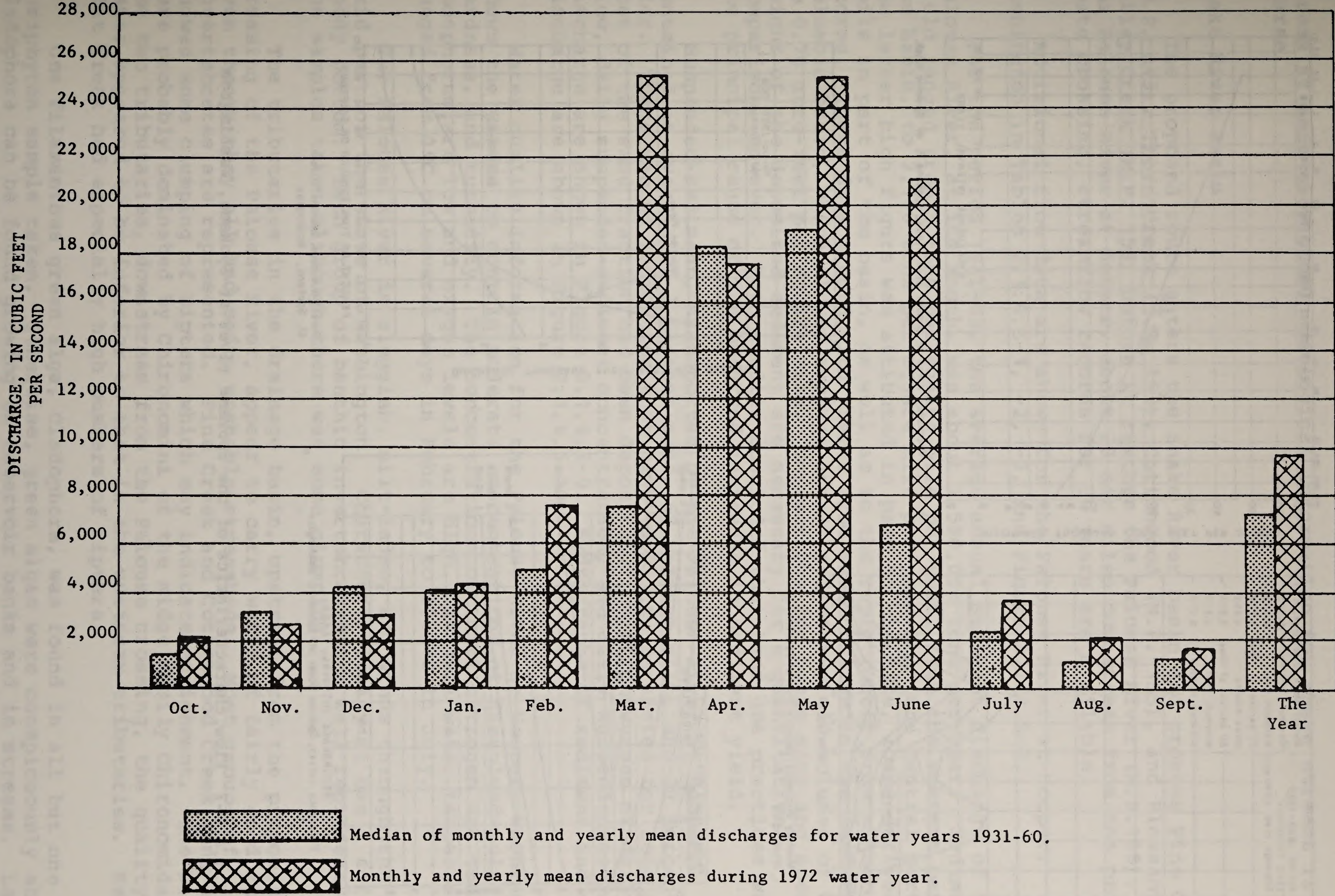


Figure 2.1.4.5-6 Runoff during the 1972 water year compared with the median runoff for the period 1931-60 for a representative gaging station, Spokane river at Spokane, Washington

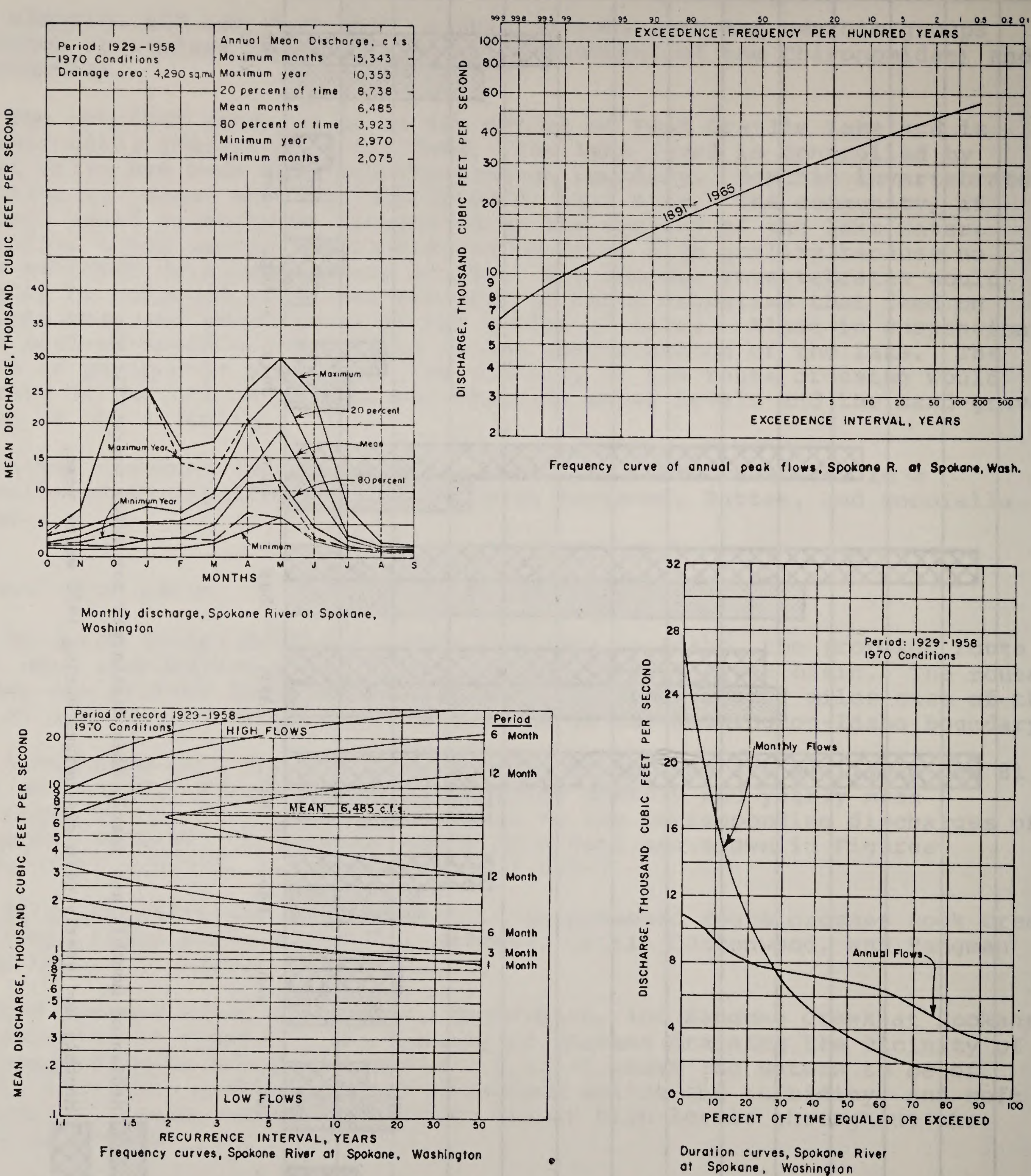


Figure 2.1.4.5-7 Flow characteristics of the Spokane river at Spokane, Washington

stream at this elevation. Biological information for these streams is sparse.

Snake River Basin

The proposed route enters the Snake River basin and crosses Pine Creek (M.P. 143), Thorn Creek (M.P. 152), Cottonwood (M.P. 155), and Pleasant Valley Creek (M.P. 159) before it reaches the Palouse River (M.P.168). For the Palouse River at Hooper, about 28 air miles downstream from the proposed route crossing, streamflow records for 34 years are available.

Additional flow data are shown for the Palouse River at Hooper, Washington in Tables 2.1.4.5-1, -2, -3, and Figure 2.1.4.5-8.

For the period 1961-65, the average annual sediment discharge of the Palouse River, at its mouth, was about 1,580,000 tons per year. Sediment yield ranged from 5 tons per square mile per year, from the western part of the basin, to 2,100 tons per square mile per year from the central part. The latter high figure was attibuted in part to the bare, loess-derived soils in part of the basin, as well as to the rapid runoff from winter storms. These data accord with yields from small basins in the eastern Columbia basin, which showed average annual sediment-yield volumes of 0.12 to 0.70 acre-feet per square mile. Corrections for basin size and specific weight of the deposited sediment are necessary for a quantitative comparison, however. Both studies concluded that land use practices were the principal cause of the observed increases in sediment yield.

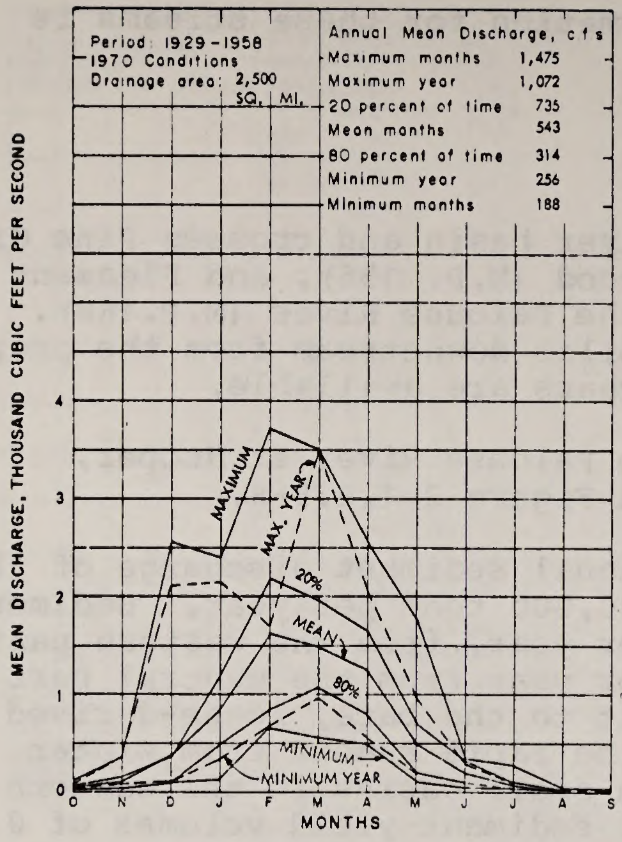
Suspended-sediment, transported by the Palouse River at Hooper, contained an average of 3 percent sand, 68 percent silt, and 29 percent clay. There was no indication that high turbidity persisted for long after most of the sand fraction had been deposited. Duration curves of daily flow, daily suspended-sediment concentration, and daily suspended-sediment discharge are shown in Figure 2.1.4.5-9. Hydrographs of sediment and water discharge are shown in Figure 2.1.4.5-10.

Water quality information for the Palouse River at Hooper, Washington shows the waters to contain moderate concentrations of dissolved-solids, hardness, and turbidity. The concentrations of total nitrogen and total phosphorus are low and oxygen levels are high. In 1971 water temperatures ranged from 0°C on several days in February to 30.0°C in July.

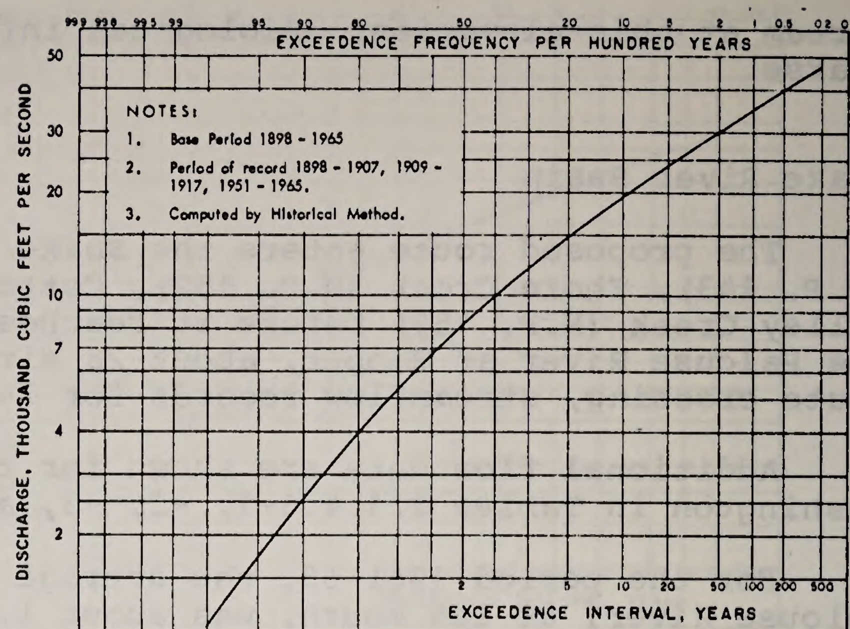
The Palouse River is sluggish, silt-laden, and winds through the semi-arid part of the state of Washington. Characteristically it has a soft muddy bottom. Each group of benthic invertebrates was well represented in the samples taken although there was some clumping.

The tributaries in the drainage basin, upstream from the proposed crossing of the Palouse River, appear to carry water of fairly good quality even though they all had soft, unstable streambeds. Most groups of invertebrates are represented. Pine Creek and Cottonwood Creek (one sample) showed some clumping of Diptera which may indicate enrichment. The Diptera were probably dominated by Chironomini of the midge family Chironomidae. In the two tributaries, downstream from the Palouse crossing, the quality of water appeared to be inferior to that in the upstream tributaries. Rebel Flat Creek had especially high numbers of Diptera.

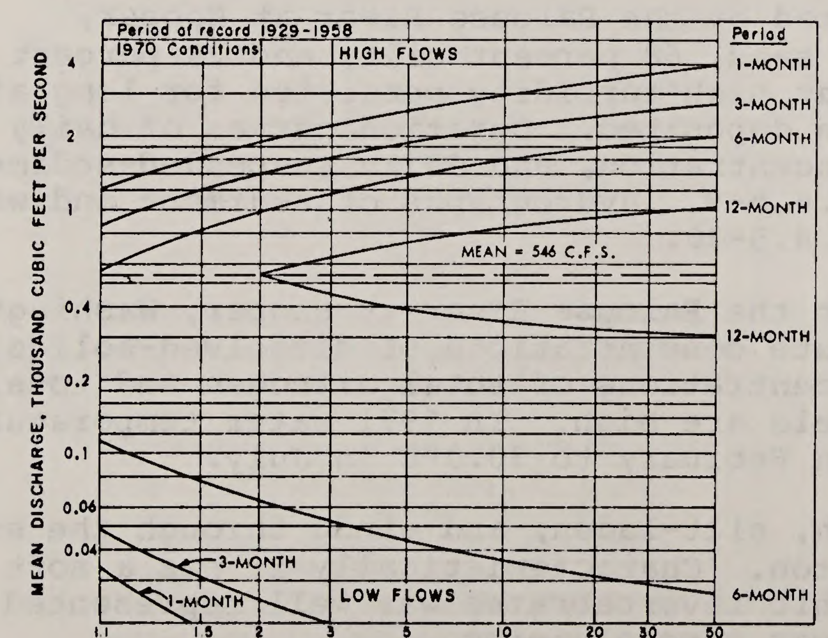
One filamentous green alga, Cladophora, was found in all but one periphyton sample taken. Otherwise, green algae were conspicuously absent. Cladophora can be found growing on reservoir banks and in streams. Large concentrations of this alga emit a septic odor. In only one site was blue-



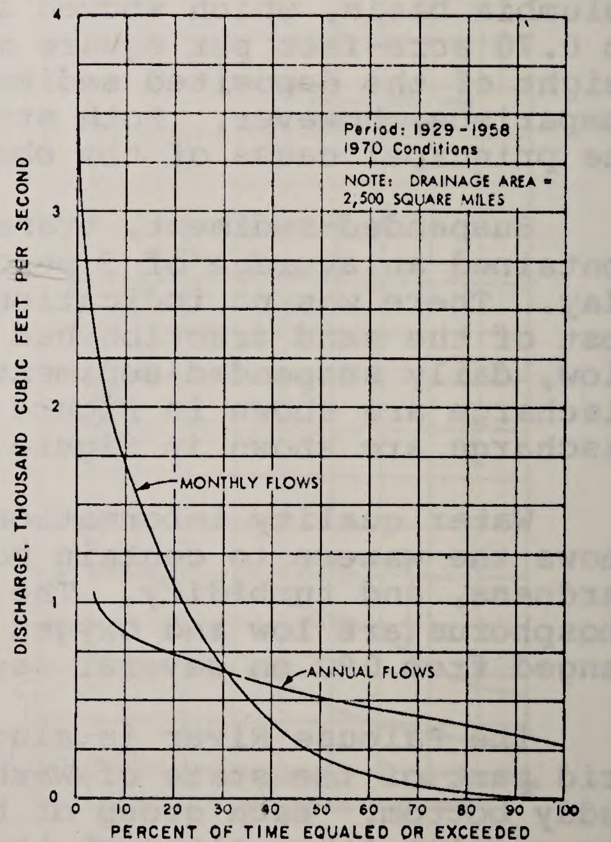
Monthly discharge, Palouse River at Hooper, Washington



Frequency curve of annual peak flows, Palouse River at Hooper, Wash.



Frequency curves, Palouse River at Hooper, Washington



Duration curves, Palouse River at Hooper, Washington

Figure 2.1.4.5-8 Flow characteristics of the Palouse river at Hooper, Washington

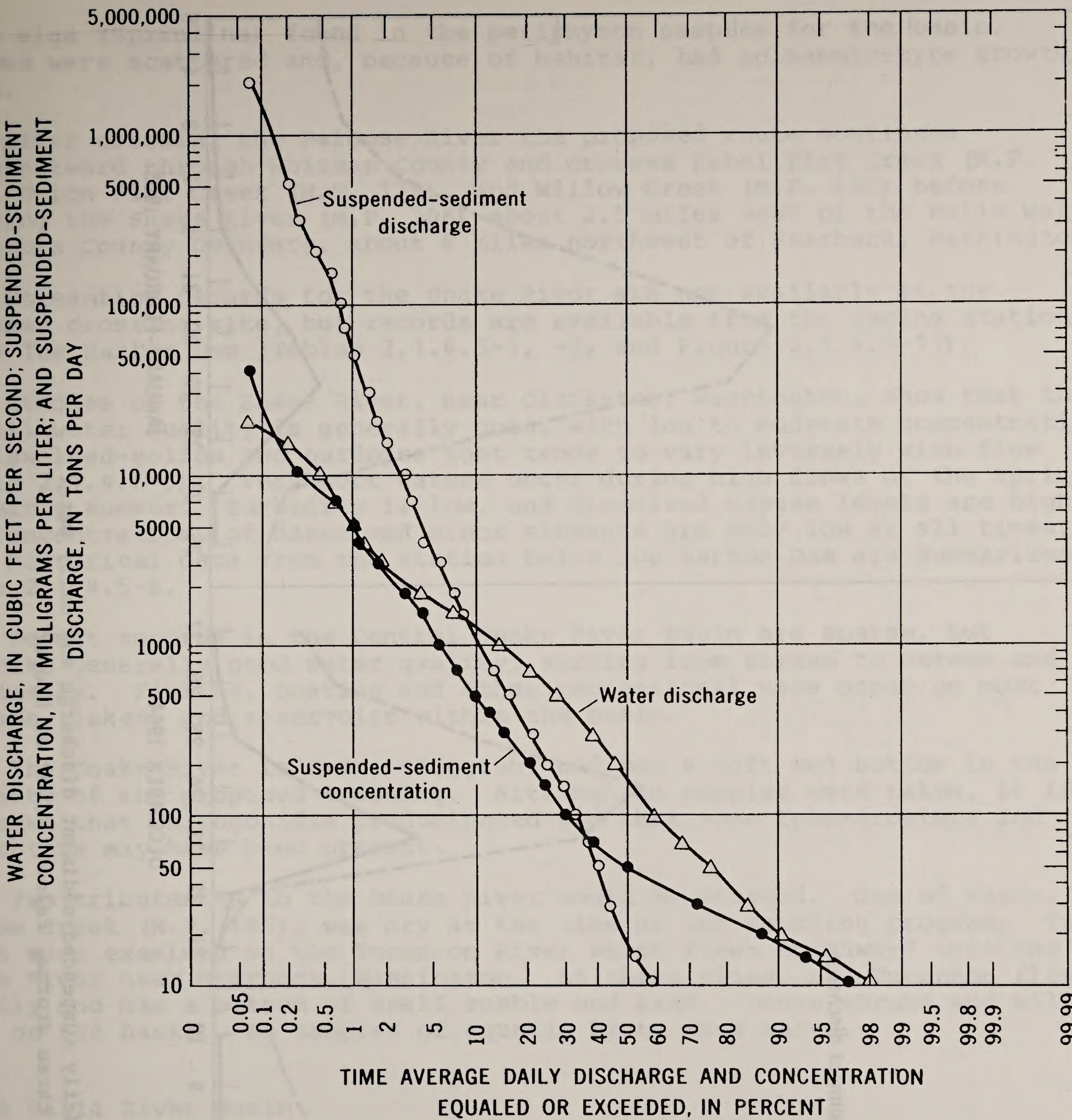


Figure 2.1.4.5-9 Duration curves of daily flow, daily suspended-sediment concentration and daily suspended-sediment discharge, Palouse river at Hooper, July 1, 1961 - June 30, 1965

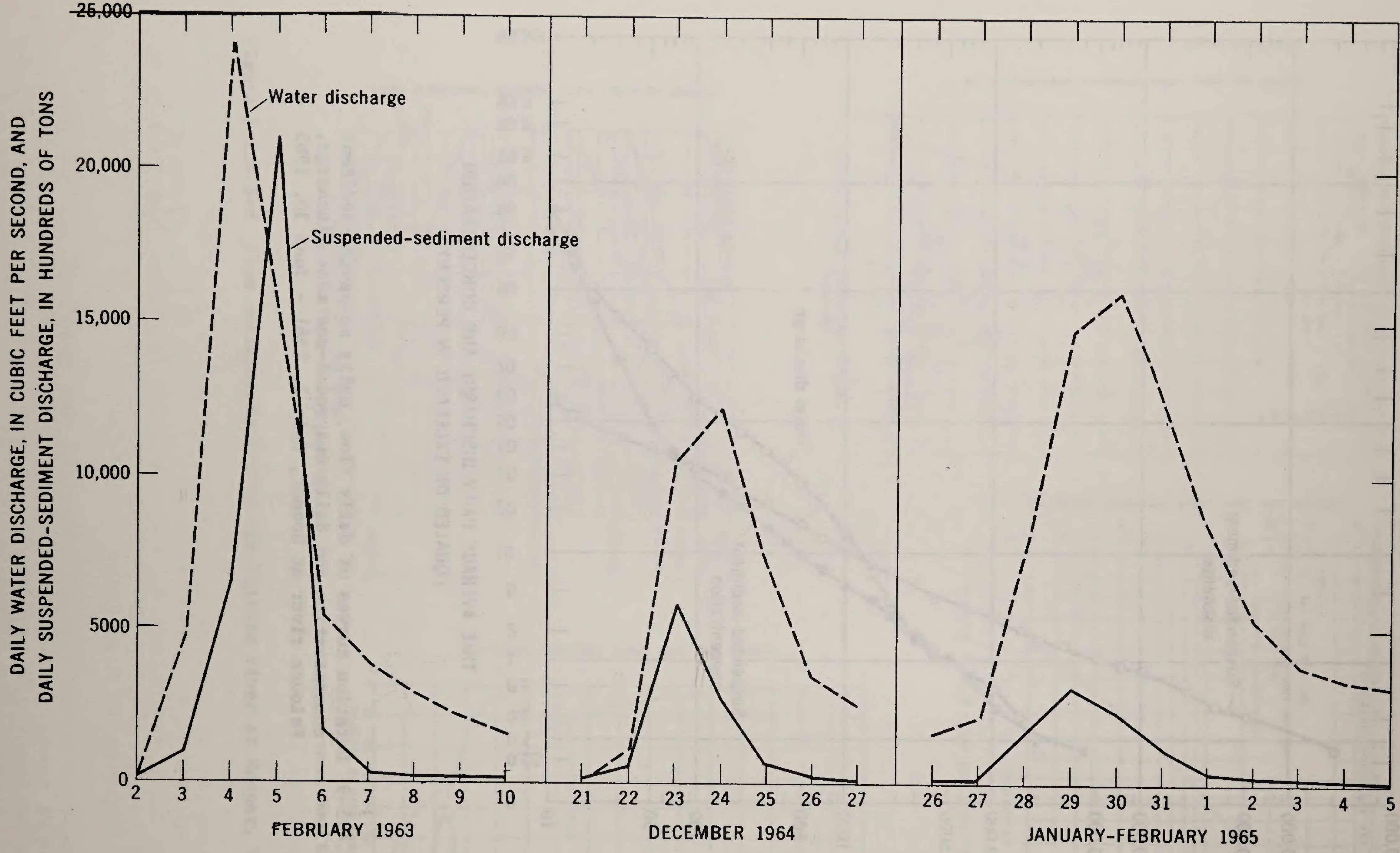


Figure 2.1.4.5-10 Hydrographs of daily suspended-sediment discharge and daily water discharge for three storms, Palouse river at Hooper

green alga (Spirulina) found in the periphyton samples for the basin. Diatoms were scattered and, because of habitat, had episammic-type growth forms.

After crossing the Palouse River the proposed route continues southwestward through Whitman County and crosses Rebel Flat Creek (M.P. 172), Union Flat Creek (M.P. 179), and Willow Creek (M.P. 185) before reaching the Snake River (M.P. 206) about 2.5 miles east of the Walla Walla--Columbia County boundary, about 4 miles northwest of Starbuck, Washington.

Streamflow records for the Snake River are not available at the proposed crossing site, but records are available from the gaging station below Ice Harbor Dam (Tables 2.1.4.5-1, -3, and Figure 2.1.4.5-11).

Studies of the Snake River, near Clarkston, Washington, show that the overall water quality is generally good, with low to moderate concentrations of dissolved-solids and hardness that tends to vary inversely with flow (Table 2.1.4.5-5). Very soft waters occur during high flows of the spring and early summer. Turbidity is low, and dissolved oxygen levels are high. The concentrations of dissolved minor elements are very low at all times. Some historical data from the station below Ice Harbor Dam are summarized in Table 2.1.4.5-6.

Recent records in the Central Snake River basin are sparse, but indicate generally good water quality, varying from stream to stream and seasonally. Fishing, boating and other recreational uses occur on most streams, lakes, and reservoirs within the basin.

The Snake River is deep, sluggish, and has a soft mud bottom in the vicinity of the proposed crossing. Although no samples were taken, it is presumed that Chironomidae predominated and that some Ephemeroptera and Coleoptera may have been present.

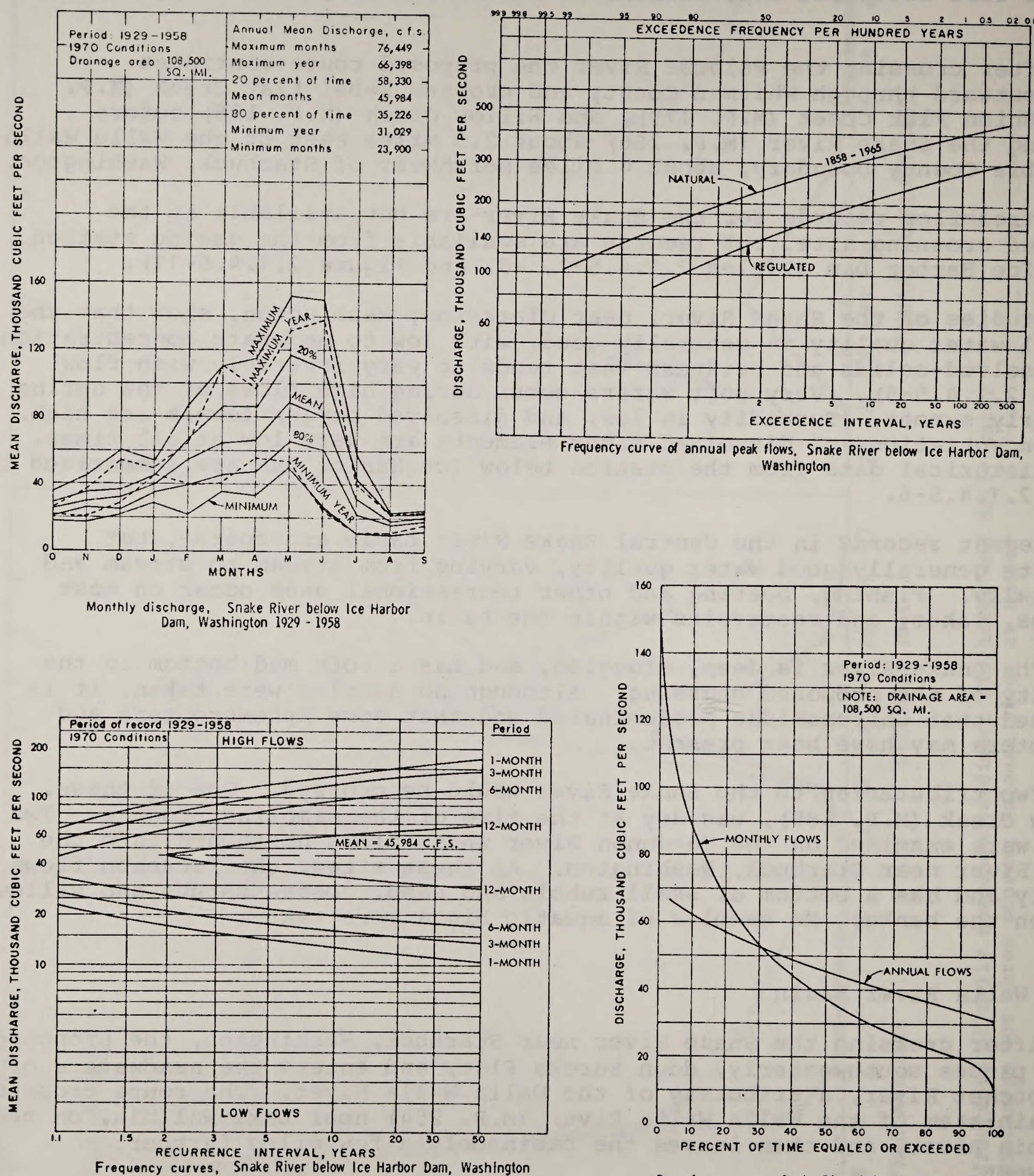
Two tributaries to the Snake River would be crossed. One of these, Willow Creek (M.P. 185), was dry at the time of the sampling program. Two sites were examined on the Tucannon River which flows northward into the Snake River near Starbuck, Washington. At these sites, the Tucannon flows rapidly and has a bottom of small rubble and sand. Dense shrubs and willows grow on the banks. No samples of aquatic biota were taken.

Walla Walla River Basin

After crossing the Snake River near Starbuck, Washington, the proposed route passes southwesterly, down Eureka Flat, and enters the headwaters of the Touchet River, a tributary of the Walla Walla River. The route crosses the main-stem of the Walla Walla River (M.P. 254) near Lake Wallula, on the Columbia River, and then leaves the basin only a few miles farther southwest.

Streamflow data for the Walla Walla River near Touchet, Washington, are available for 21 years. (Table 2.1.4.5-1, Table 2.1.4.5-2, Table 2.1.4.5-3, and Figure 2.1.4.5-12).

Daily sediment data are available for the Walla Walla River, near Touchet, from 1962 to 1970 (Table 2.1.5.4-4). For the period July 1962-June 1965, sediment yields in the basin ranged from 420 tons per square mile per year from mountainous terrain, to more than 4,000 tons per square mile per year from agricultural land. Daily suspended-sediment concentrations exceeded 700 mg/l about 10 percent of the time, and 14,000 mg/l about one percent of the time (Figure 2.1.4.5-13). The discharge-weighted mean



Monthly discharge, Snake River below Ice Harbor Dam, Washington 1929 - 1958

Frequency curve of annual peak flows, Snake River below Ice Harbor Dam, Washington

Frequency curves, Snake River below Ice Harbor Dam, Washington

Duration curves, Snake River below Ice Harbor Dam, Washington

Figure 2.1.4.5-11 Flow characteristics of the Snake river below Ice Harbor dam, Washington

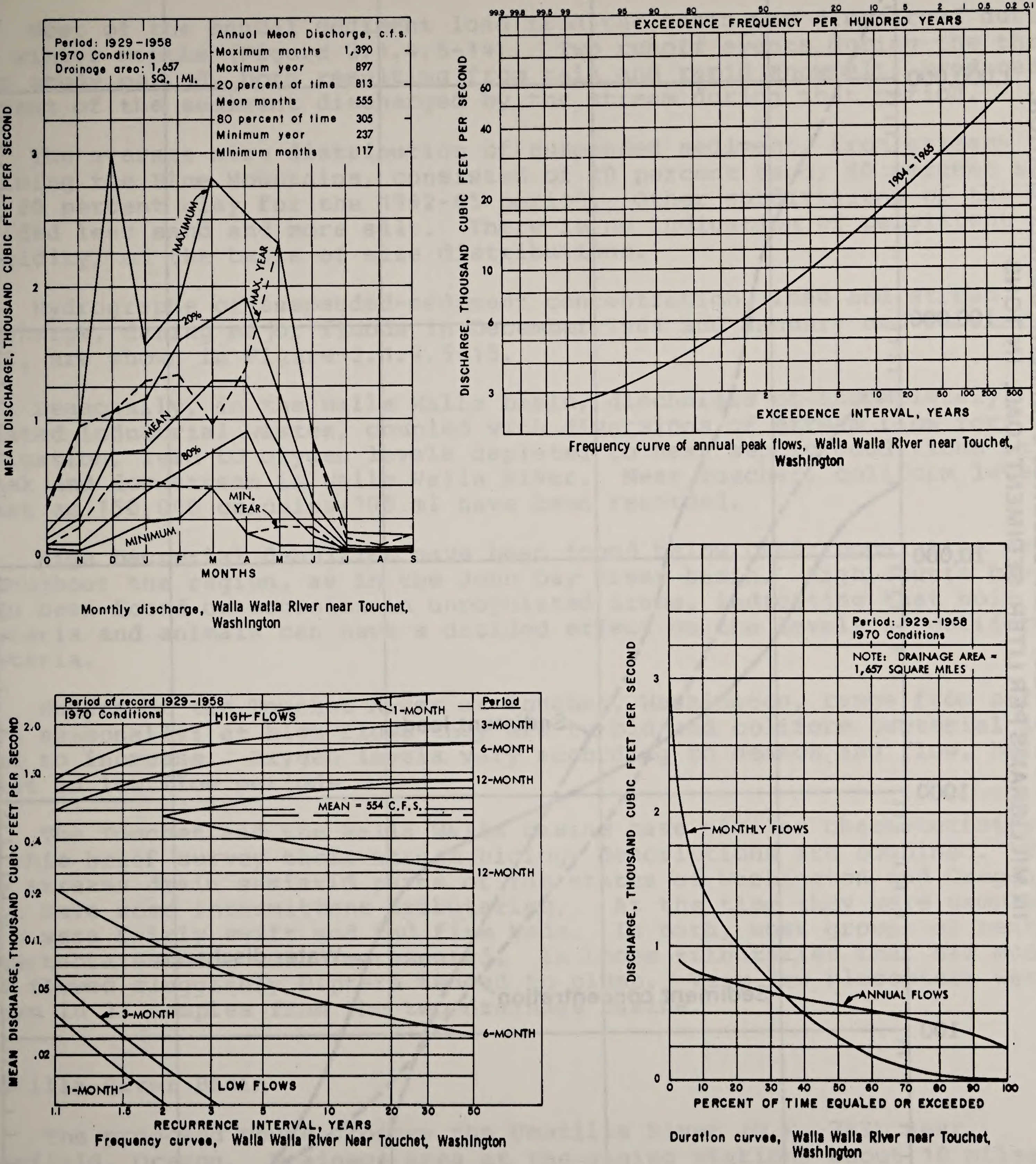


Figure 2.1.4.5-12 Flow characteristics of the Walla Walla River near Touchet, Washington

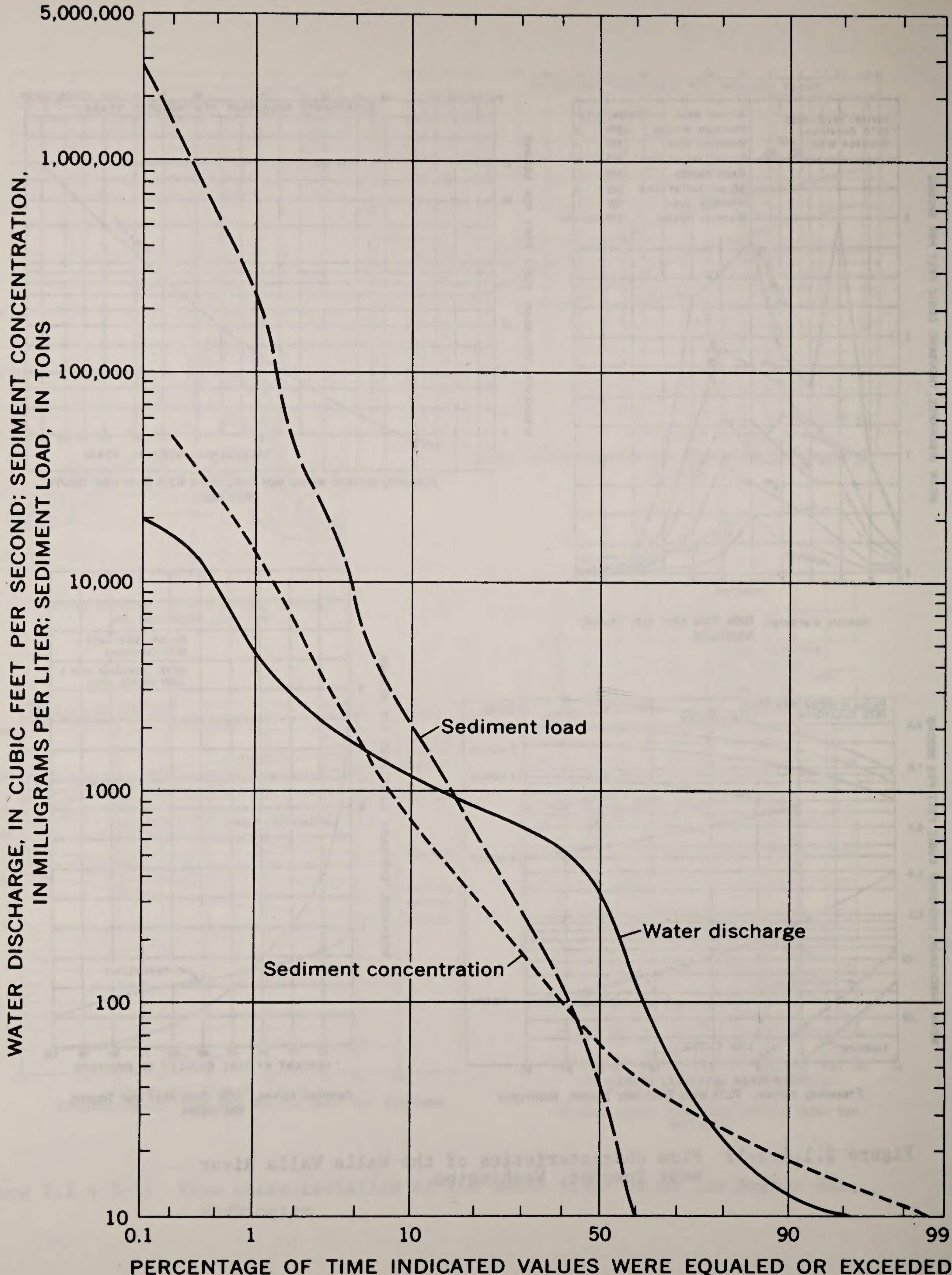


Figure 2.1.4.5-13 Frequency curves for mean daily water discharge, sediment concentration, and sediment load, Walla Walla river near Touchet, July 1962 - June 1965

concentration, for the study period, was 7,000 mg/l. A single sample from a tributary (Dry Creek) had a concentration of more than 300,000 mg/l.

Most of the annual sediment load from the basin was discharged during the winter months (Figure 2.1.4.5-14). Two runoff events during the three year study period, both resulting from rain and rapid snowmelt, produced 76 percent of the sediment discharged by the stream during that period.

The average size distribution of suspended sediment, from streams draining the Blue Mountains, consisted of 20 percent sand, 60 percent silt, and 20 percent clay for the 1962-65 period. Other subdivisions of the basin yielded less sand and more silt. There is no indication of persistent turbidity, on the basis of size distributions.

Hydrographs of suspended-sediment concentration, load and stream discharge, during major floods in December 1964 and January and February 1965, are shown in Figure 2.1.4.5-15.

Seasonally, in the Walla Walla basin, discharges of incompletely treated industrial wastes, coupled with diversions of stream flow for irrigation, lead to oxygen levels depleted to near septic conditions in Mill Creek and downstream in Walla Walla River. Near Touchet, coliform levels as great as 150,000 colonies/100 ml have been recorded.

High bacterial densities have been found below other population centers throughout the region, as in the John Day River basin. High counts have also been found on occasion in unpopulated areas, indicating that soil bacteria and animals can have a decided effect on the levels of coliform bacteria.

Waters of the Touchet River at Touchet, Washington, range from soft to hard seasonally; at high flows they are turbid and coliform bacterial levels tend to increase. Oxygen levels vary according to season and flow, being least in low flow periods.

The Touchet and the Walla Walla basins have similar characteristics, so in this brief survey their stream biology descriptions are combined. The two streams drain semiarid parts of the states of Washington and Oregon. Both have some intermittent tributaries. At the time they were sampled, both were fairly swift and had firm beds. In both, most groups of benthic invertebrates were well represented. In those tributaries that had mud beds and flowed sluggishly Diptera tended to clump. Very few Plecoptera were taken in 21 samples from the two drainage basins.

Umatilla River Basin

The proposed route crosses the Umatilla River (M.P. 283) near Stanfield, Oregon. Drainage area at the gaging station, about 10 miles downstream from the crossing, is 2,290 square miles. Average discharge at the gauge is 437 cfs (cubic feet per second) based on 45 years of record (1927-72) (Table 2.1.4.5-1). Maximum flow was 19,800 cfs, in January 1965. Other flow characteristics are shown in Table 2.1.4.5-3, and Figure 2.1.4.5-15. A reservoir on McKay Creek, south of Pendleton and upstream from the pipeline crossing, stores spring runoff water and releases it during late summer to sustain Umatilla River flows for downstream irrigation diversions.

Daily sediment data are available for the Umatilla River at a site near Umatilla for the period 1962-70 (Table 2.1.4.5-4). Figure 2.1.4.5-16 graphs suspended-sediment concentration, load, and stream discharge during major floods in December 1964, January and February 1965.

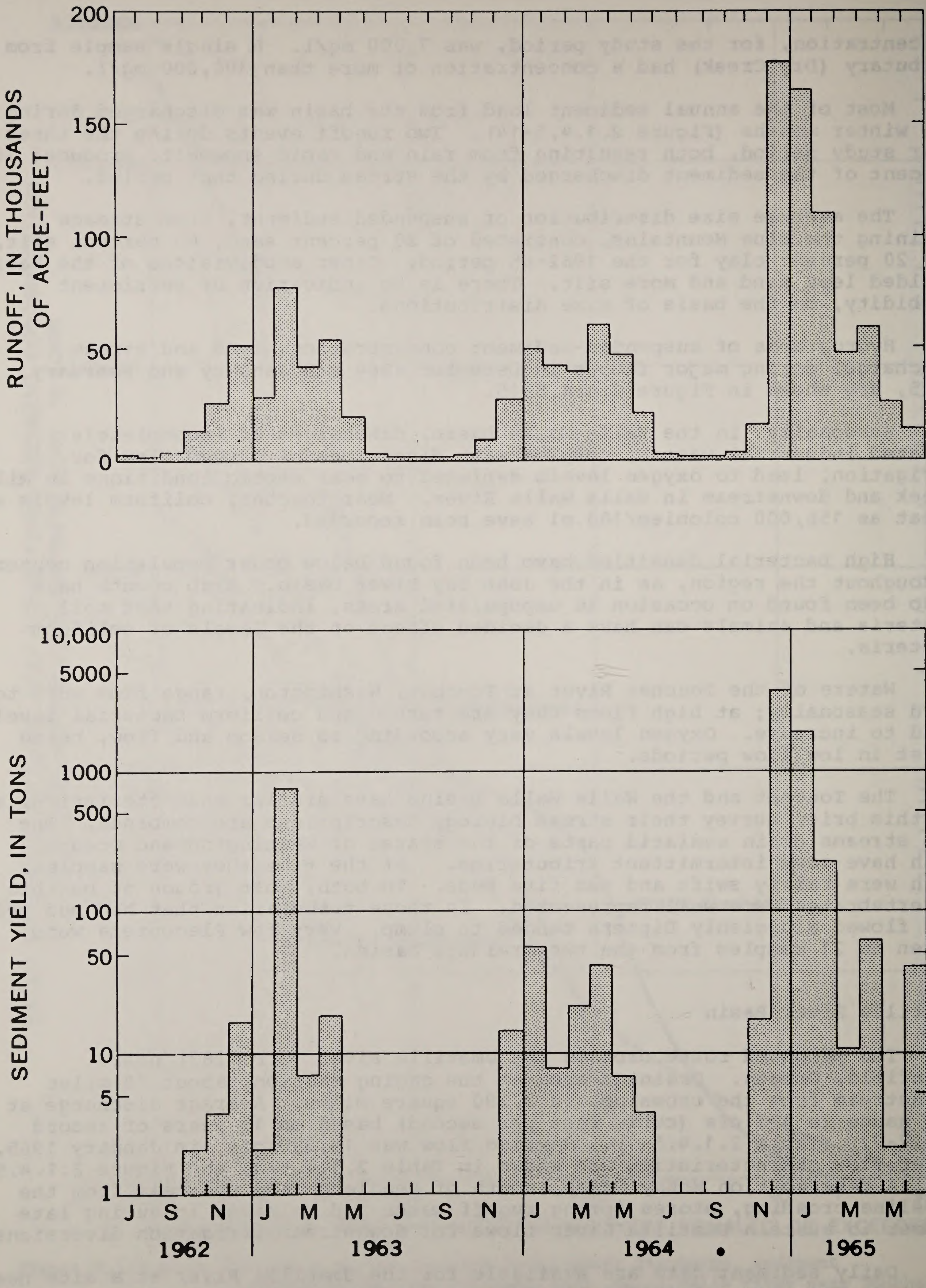


Figure 2.1.4.5-14 Seasonal variation in runoff and sediment yield, Walla Walla river near Touchet

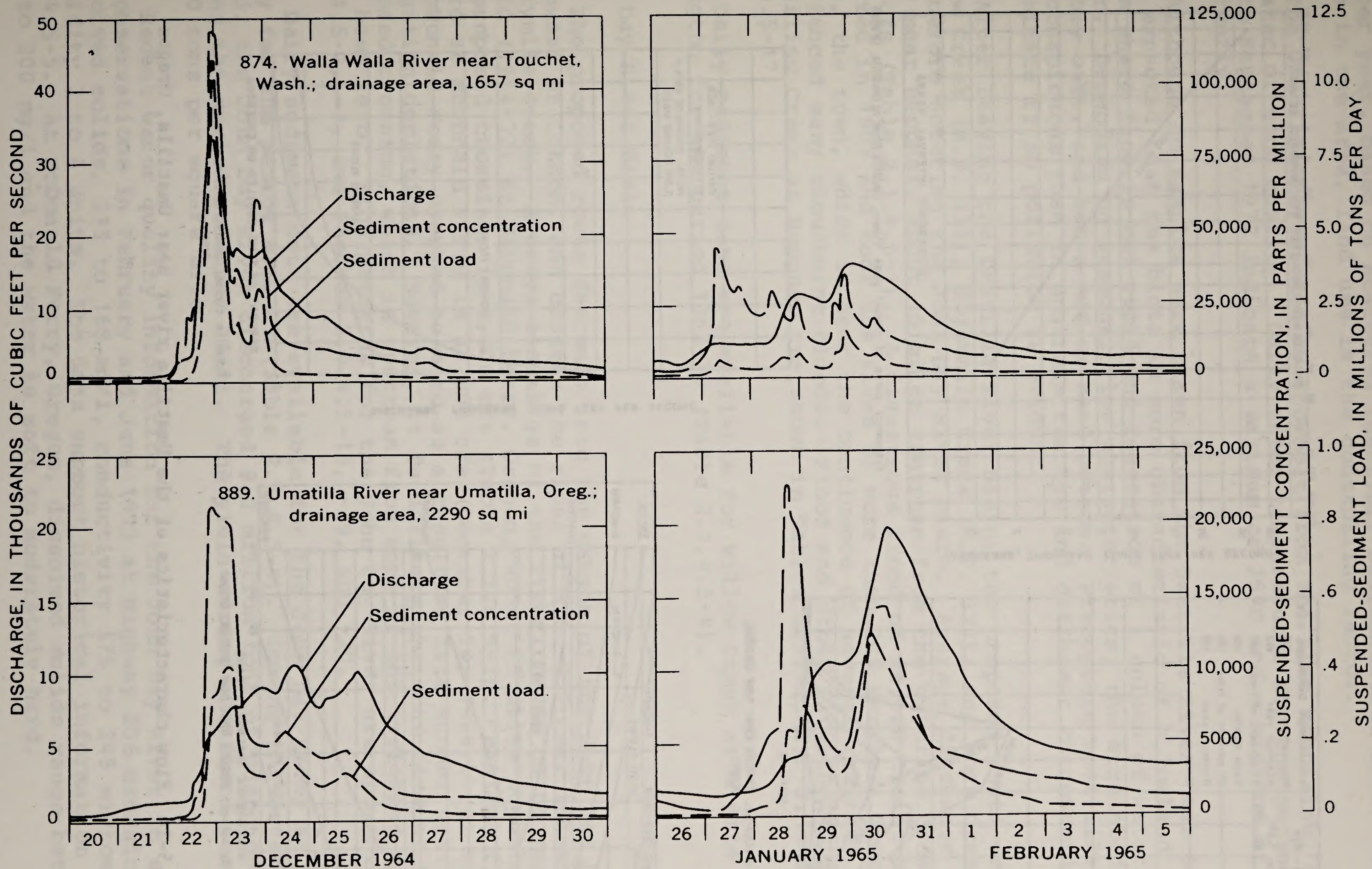
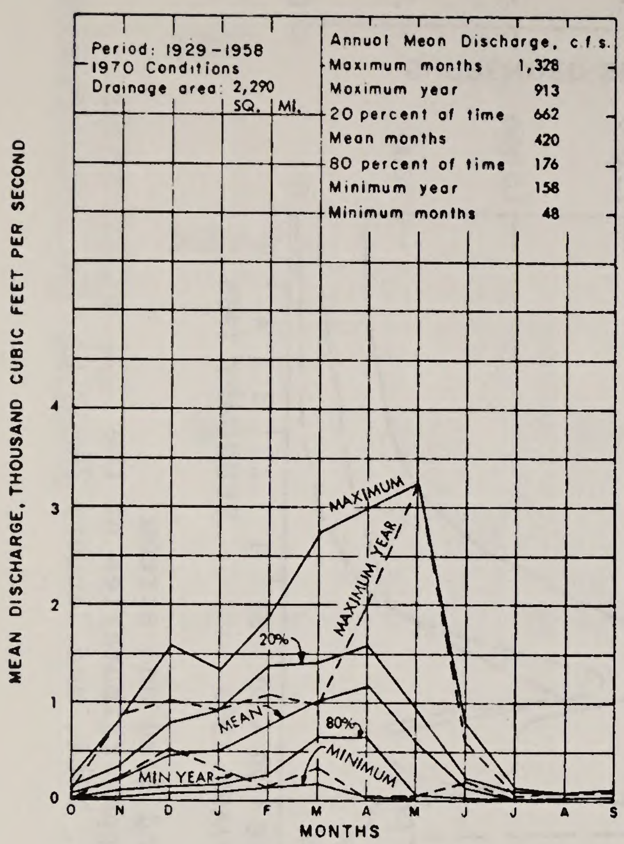
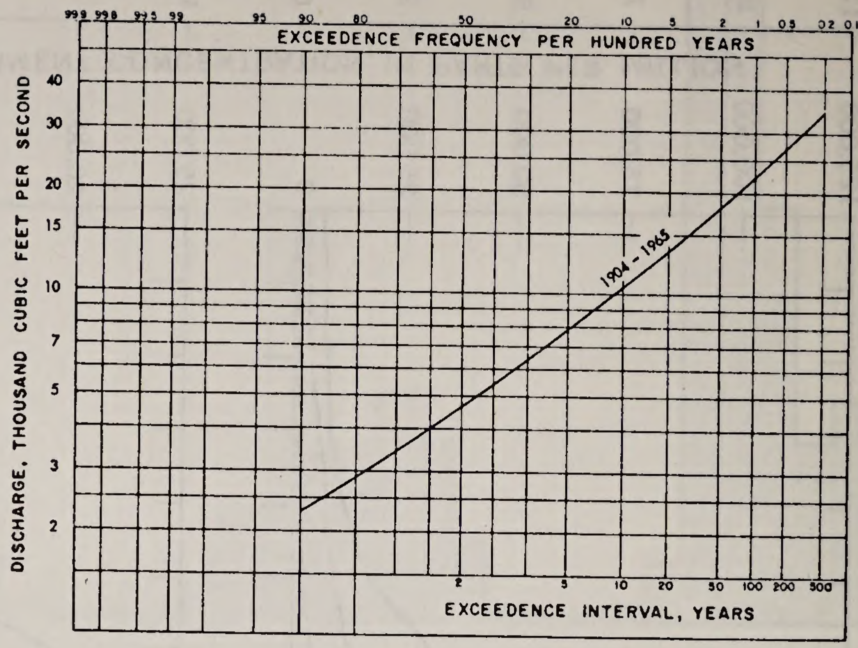


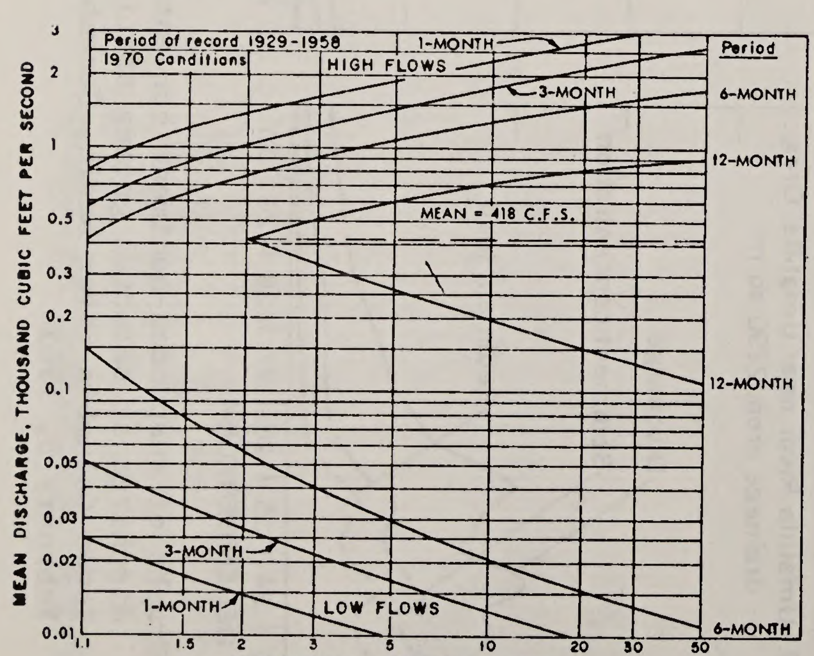
Figure 2.1.4.5-15 Graphs of suspended-sediment concentration and load and stream discharge at selected gaging stations in upper tributaries of the lower Columbia river basin, December 20-30, 1964, and January 26-February 5, 1965



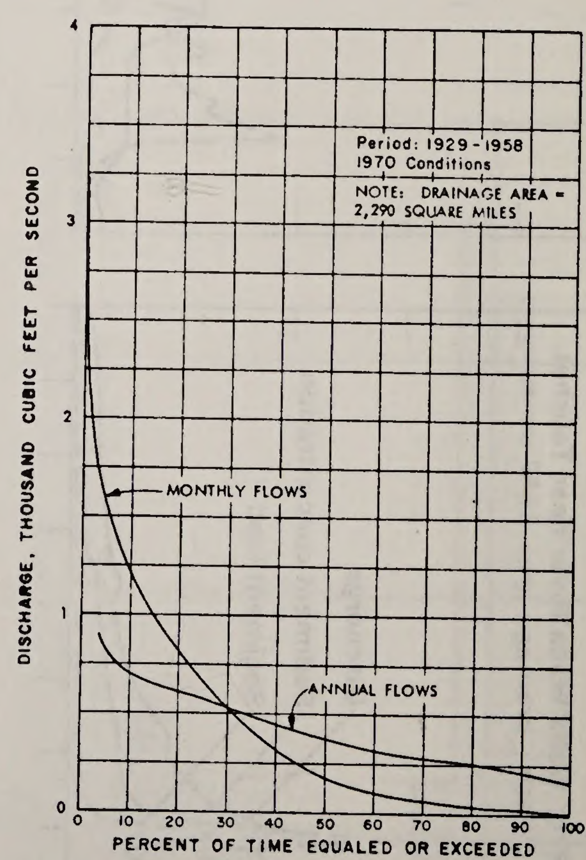
Monthly discharge, Umatilla River near Umatilla, Oregon



Frequency curve of annual peak flows, Umatilla River nr. Umatilla, Oregon



Frequency curves, Umatilla River near Umatilla, Oregon



Duration curves, Umatilla River near Umatilla, Oregon

Figure 2.1.4.5-16 Flow characteristics of the Umatilla river near Umatilla, Oregon

Sediment yields for this area are less than one acre foot per square mile per year, based on scattered reservoir-sedimentation data. As in other basins in the area, land use is the controlling factor.

The Umatilla River, fed by snowmelt from the Blue Mountains, generally has water of good quality. Daily water temperatures for the period June 1959 to September 1972 indicate a maximum of 25°C and a minimum of 0°C, both recurrently.

Although no samples were taken from the Umatilla River near Stanfield, it is expected that the biota is more characteristic of a lowland type stream where flow is not rapid and reaeration of a column of water is much slower. Depending on seasonal flow characteristics, the streambed is probably soft, and has a mud or sand bottom. Plecoptera most likely will be less conspicuous than in upstream reaches and different Chironomidae may predominate if no pollution is evident.

After leaving the Umatilla River basin, the proposed route crosses Willow Creek (M.P. 318), Eightmile Creek (M.P. 327), and Rock Creek (M.P. 332) before entering the John Day River basin. Average discharge of Willow Creek near Heppner, about 15 miles upstream from the pipeline crossing, is 18.6 cfs (Table 2.1.4.5-1). A disastrous flood of 36,000 cfs at Heppner, occurred in 1903 and took the lives of more than 200 people. Over the years, the town, which is near the confluence of several ravines, has experienced many cloudburst floods. Flood and other flow characteristics for Willow Creek at Heppner are shown in Tables 2.1.4.5-2, -3, and Figure 2.1.4.5-17.

Daily sediment data are available for Willow Creek at a site near Arlington for the period 1962-70 (Table 2.1.4.5-4).

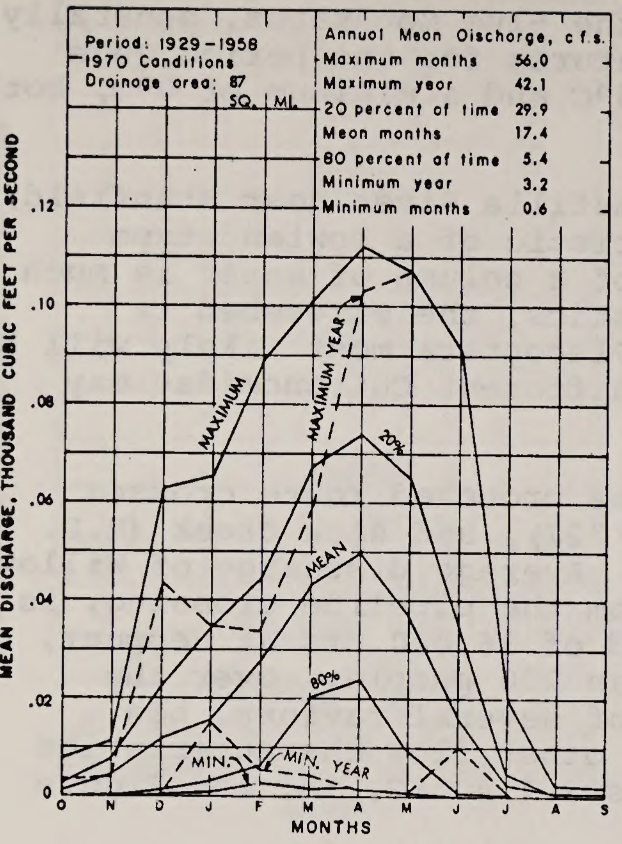
John Day River Basin

The proposed route descends into the canyon of the John Day River southwest of Condon, and crosses the river at M.P. 357 near the mouth of Thirtymile Creek. Average discharge of the river, based on 68 years of record (1904-72) at McDonald Ferry, Oregon, about 25 miles downstream from the proposed crossing, is 2,006 cfs (Table 2.1.4.5-1). Maximum flow of record at McDonald Ferry is 42,800 cfs (December 24, 1964). At times, flow at McDonald Ferry dropped to zero as a result of late summer upstream irrigation depletions. However, it is unlikely that the flow at the proposed crossing, which is upstream from some of the irrigated areas, has ever been zero. Flow patterns for the John Day River are shown in Tables 2.1.4.5-2, -3, and Figures 2.1.4.5-18, -19, and -20.

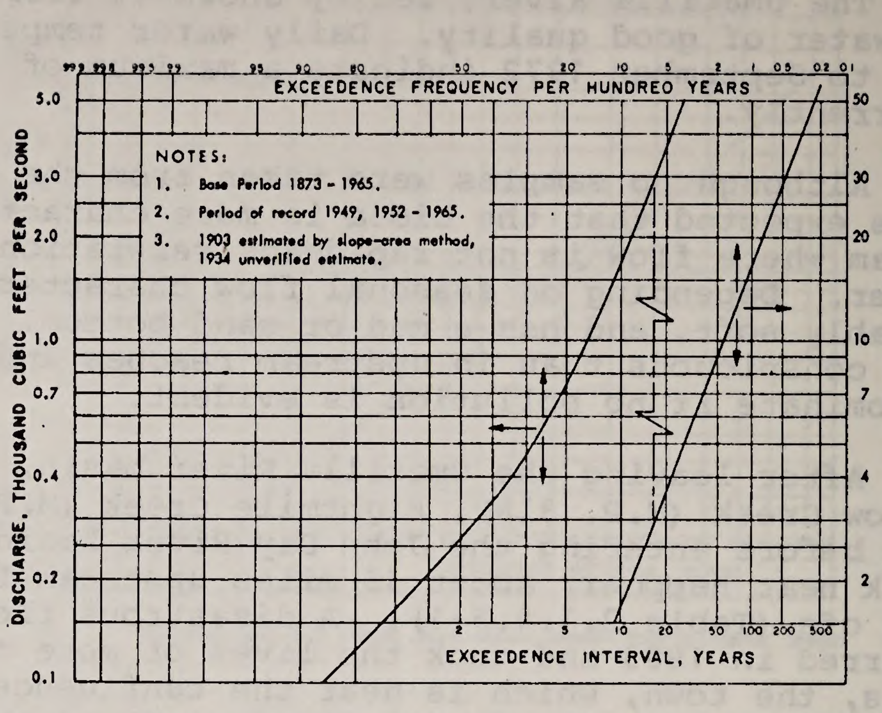
Daily sediment data are available for the John Day River at McDonald Ferry for the period 1962-70 (Table 2.1.4.5-4). During the December 1964 flood, the John Day River discharged 9.2 million tons of suspended-sediment during the period December 21-31. The yield during the flood period was 1,220 tons per square mile.

Recent water quality information for the John Day River is sparse. A few observations in February and June 1973 at Highway 206 crossing include dissolved solids, 235 to 168 mg/l, conductivity 175 to 245 micromhos, and turbidity 2 to 4 units. The data support historical information in Table 2.1.4.5-5. At McDonald Ferry, Oregon, dissolved solids range between about 100 to 200 mg/l and the water is soft to moderately hard.

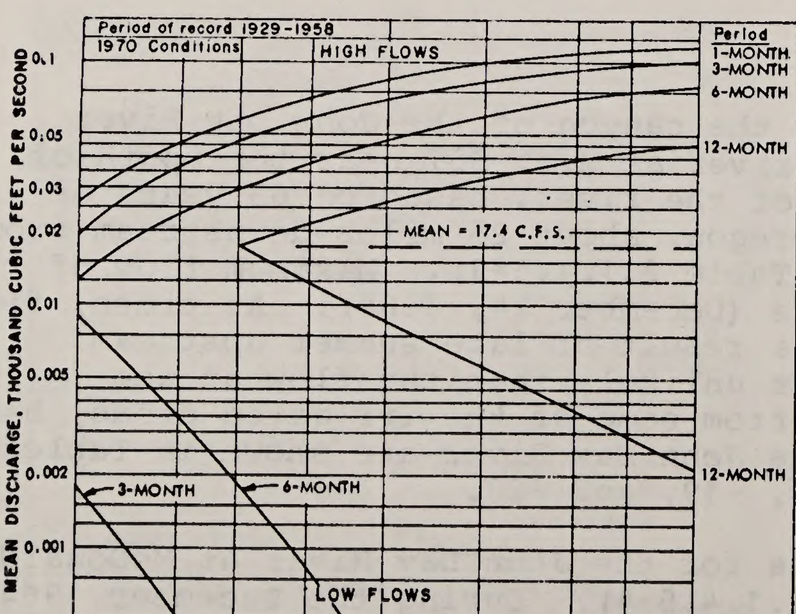
Benthic invertebrates and periphyton were not collected at the stream crossings along the proposed route corridor from north of Walla Walla,



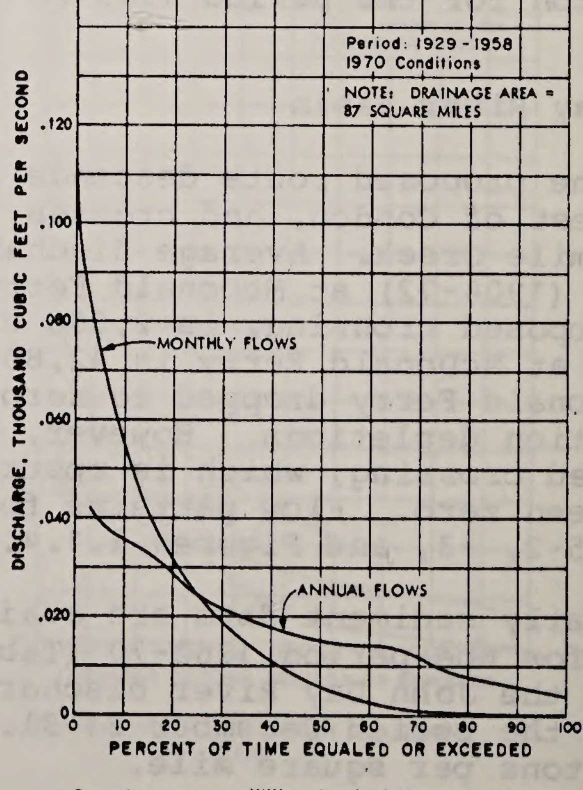
Monthly discharge, Willow Creek at Heppner, Oregon



Frequency curve of annual peak flows, Willow Creek at Heppner, Oregon

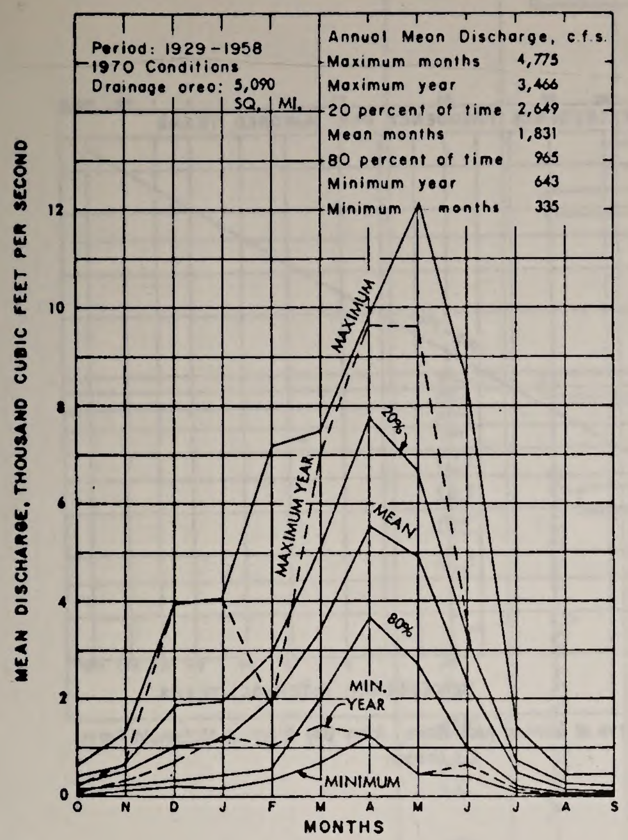


Frequency curves, Willow Creek at Heppner, Oregon

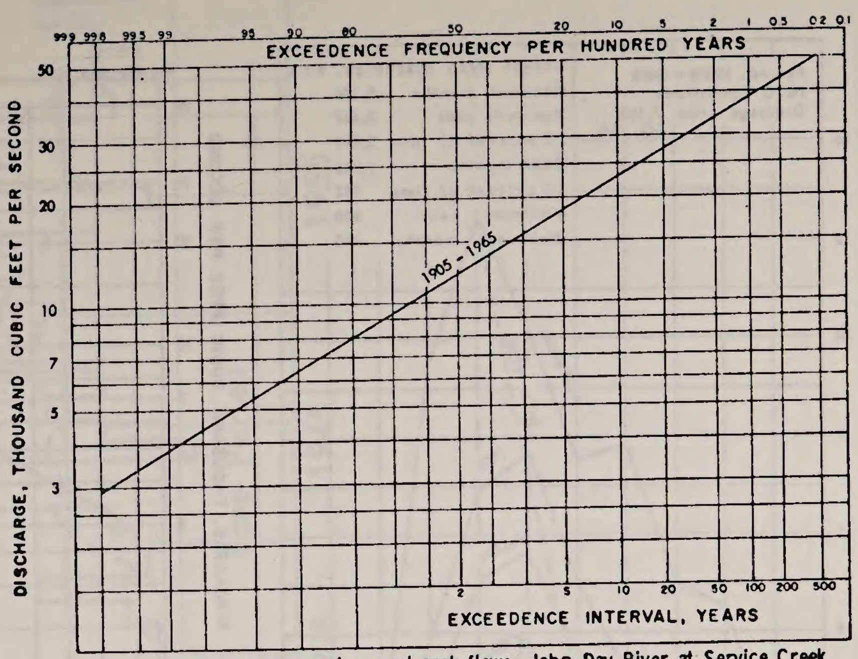


Duration curves, Willow Creek at Heppner, Oregon

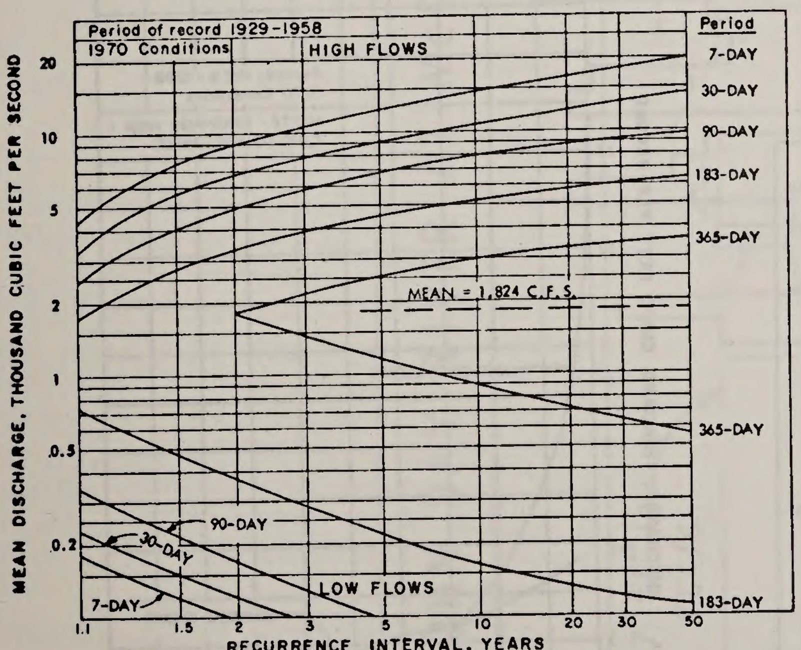
Figure 2.1.4.5-17 Flow characteristics of Willow Creek at Heppner, Oregon



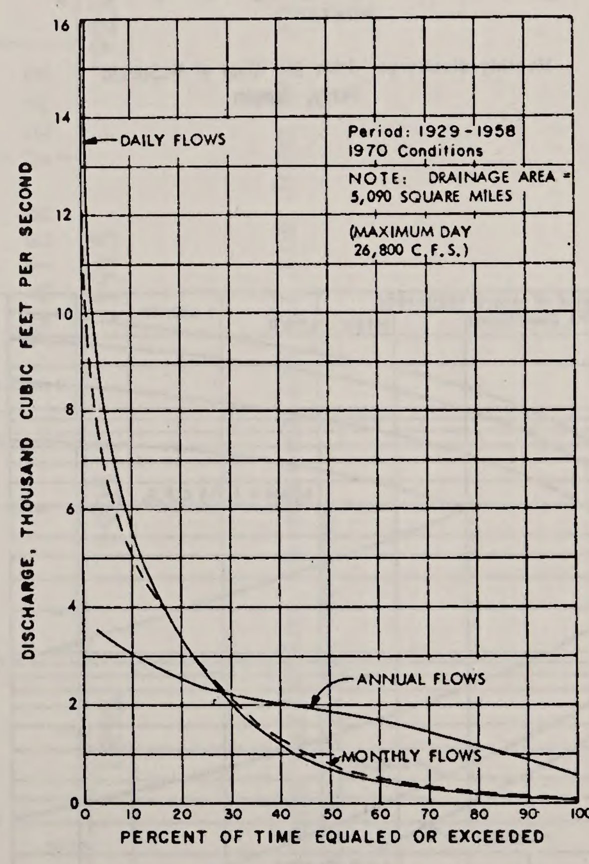
Monthly discharge, John Day River at Service Creek, Oregon



Frequency curve of annual peak flows, John Day River at Service Creek, Oregon

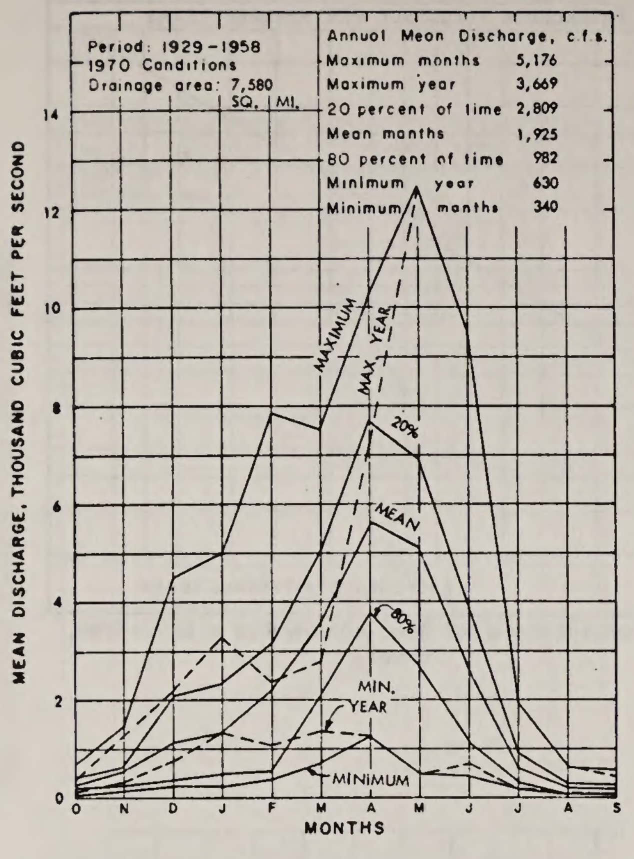


Frequency curves, John Day River at Service Creek, Oregon

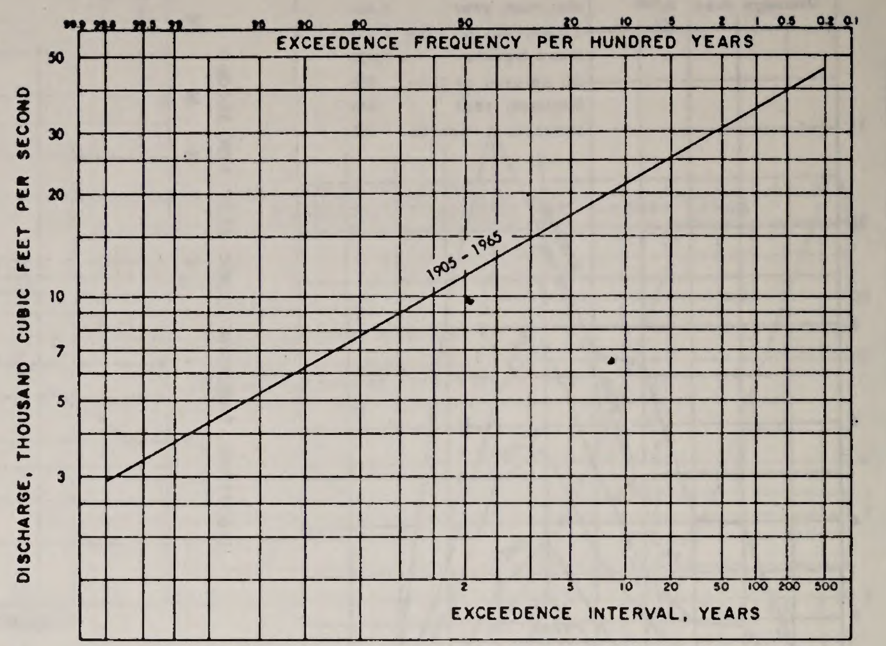


Duration curves, John Day River at Service Creek, Oregon

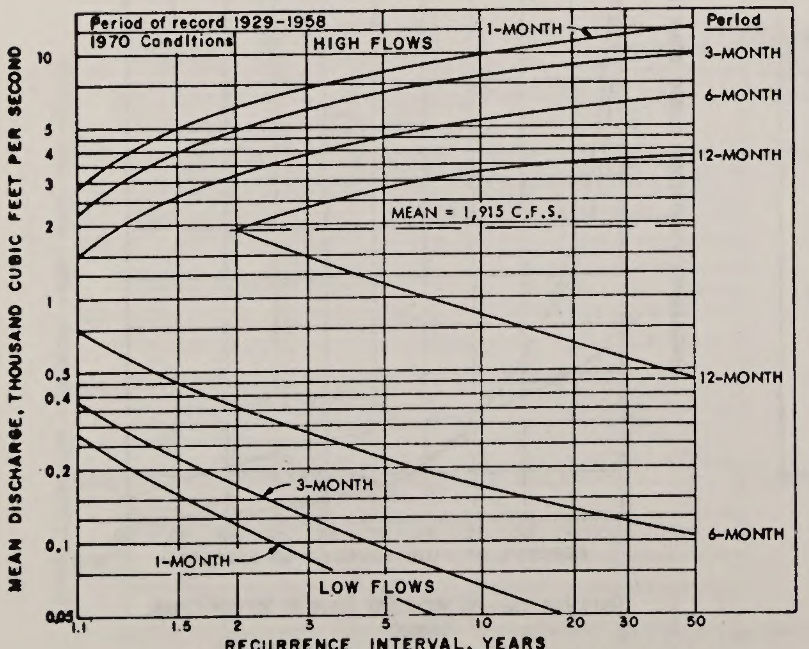
Figure 2.1.4.5-18 Flow characteristics of John Day river at Service Creek, Oregon



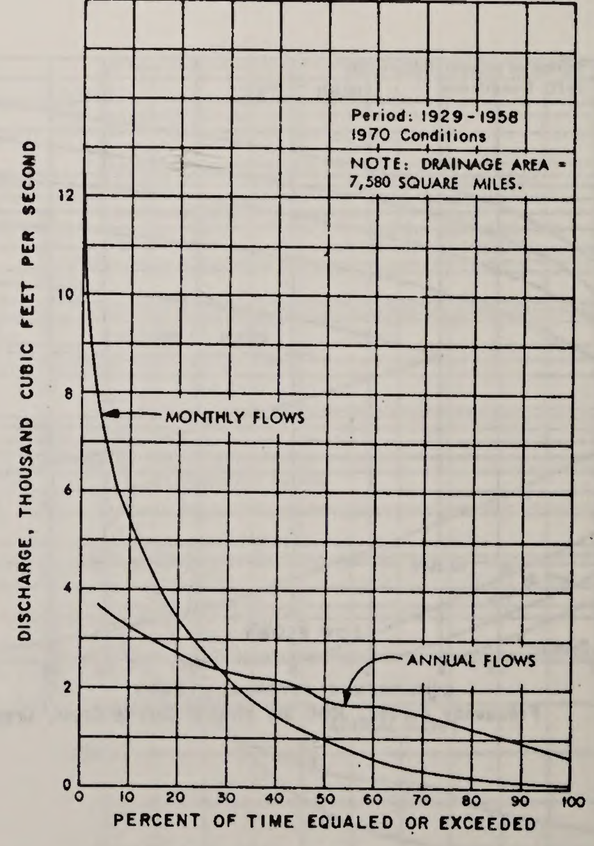
Monthly discharge, John Day River at McDonald Ferry, Oregon



Frequency curve of annual peak flows, John Day River at McDonald Ferry, Oregon



Frequency curves, John Day River at McDonald Ferry, Oregon



Duration curves, John Day River at McDonald Ferry, Oregon

Figure 2.1.4.5-19 Flow characteristics of John Day river at McDonald Ferry, Oregon

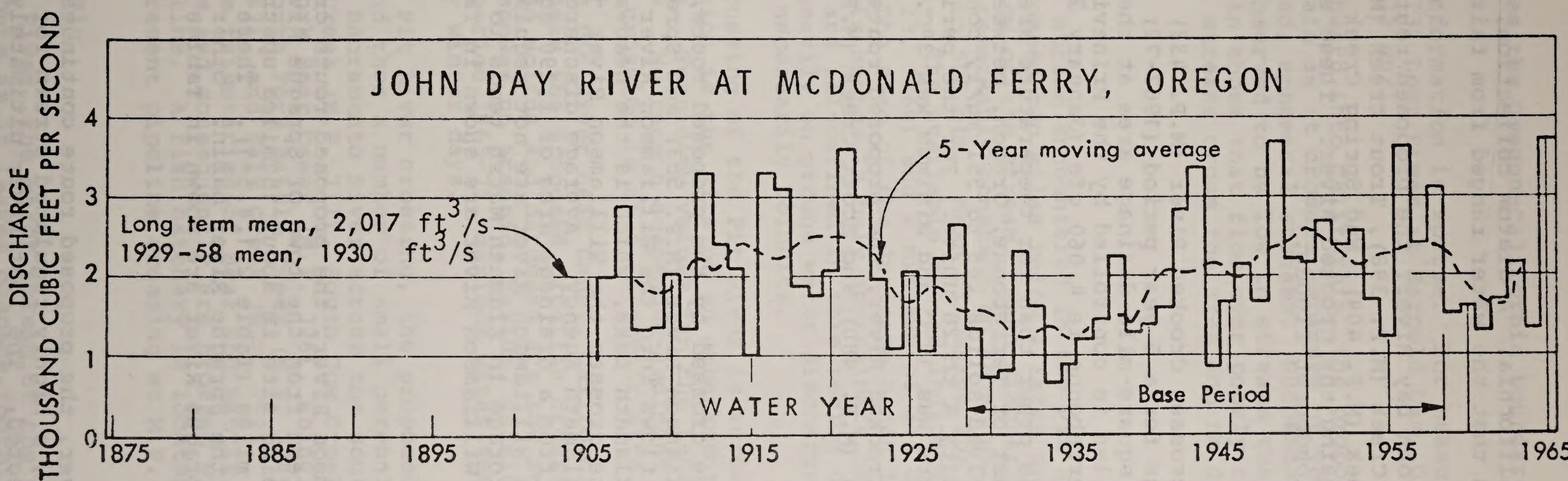


Figure 2.1.4.5-20 Long-term variation in streamflow of the John Day river at McDonald Ferry, Oregon

Washington to Antioch, California. A diatom collection, made in the John Day River in 1967, showed that the water ranged from fair to good in quality.

After crossing the John Day River, the proposed route traverses westward across Antelope Creek (M.P. 398), Trout Creek (M.P. 402), Wilson Creek (M.P. 409), Hay Creek (M.P. 404), Mud Spring Creek (M.P. 414), and Willow Creeks before crossing the Crooked River. These streams have experienced summertime cloudburst floods.

Crooked River Basin

The proposed route crosses Crooked River (M.P. 433) near Terrebonne, Oregon. Average discharge for a 5 year period (1967-72) is shown in Table 2.1.4.5-1. Of the 4,240 square-mile drainage area at the gage, runoff from the upper 2,700 square miles is controlled by the Prineville Reservoir. Maximum discharge near Terrebonne is 4,060 cfs (January 20, 1971).

Water quality records other than for temperature are sparse. Observations 4-1/2 miles east of Terrebonne, Oregon, between August 1971 and July 1973, included dissolved-solids 265 to 351 mg/l, conductivity 322 to 560 micromhos, and turbidity 4 to 28 units. For the period of record, 1963-72, the maximum temperature was 15°C and minimum was 3°C.

After crossing the Crooked River, the proposed route continues southward across Paulina Creek (M.P. 480) and Scott Creek (M.P. 542) and into the Klamath River drainage.

Williamson River Basin

The principal streams crossed by the proposed route, in the Klamath River basin, are the Williamson River (M.P. 553) and Sprague River (M.P. 576). The Sprague River flows into the Williamson River shortly before the Williamson enters Upper Klamath Lake, which is the headwater of the Link and Klamath Rivers. The route crosses the Williamson River just upstream from the gaging station near Klamath Agency. Average discharge there was 213 cfs for the period (1954-72) from a drainage area of 1,290 square miles (Table 2.1.4.5-1). Flows of the Williamson River are not regulated by any major reservoir, but natural storage in Klamath Marsh tends to subdue flood peaks. Flow characteristics for Williamson River are shown in Tables 2.1.4.5-2 and -3.

Sprague River Basin

South of the Williamson River, the proposed route crosses the Sprague River at M.P. 576 downstream from the town of Sprague River. The gaging station nearest the crossing site is about 15 miles upstream near Beatty, drainage area 513 square miles (Table 2.1.4.5-1). There are no major regulating reservoirs in the Sprague River basin. Other flow characteristics of the Sprague River are shown in Tables 2.1.4.5-2 and -3.

Lost River Basin

From the Sprague River, the proposed route continues southward across the Lost River (M.P. 798), a highly regulated stream for which only spot flow data have been collected. The Lost River ultimately empties into Tule Lake, a closed-basin lake in California. After crossing the Lost River, the

pipeline route crosses the Oregon-California boundary into the Pit River basin.

Water-quality information is sparse. For measurements in the period July 1971 to July 1973, Lost River at Harpold Dam, Oregon, dissolvedsolids ranged from 206 to 272 mg/l.

Continuing southward into California, the proposed route remains in Basin and Range terrain as it crosses expanses of young volcanic rocks marked by unintegrated, ephemeral streams. Suspended-sediment concentrations are observed to be low in streams that flow over lava, but may be locally high in those that flow over poorly consolidated clastic materials. No large streams cross the area and no data on flow or sediment are available.

Pit River Basin

The first major stream encountered in the Pit River basin is the Fall River (M.P. 679), crossed two miles below a large spring which supplies nearly the entire flow of the stream. Mean discharge measured one mile below the spring is remarkably constant on an annual basis, being generally in the range of 400 to 500 cfs. Mean discharge for the period of record (1958-67) is 460 cfs. The available record indicates a maximum discharge of 3,910 cfs (December 23, 1964) and a minimum of 353 cfs (January 29, 1962) (Table 2.1.4.5-1). The size of the drainage basin is estimated at 123 square miles, but this number is only approximate because boundaries between ground water basins are ill-defined in this region due to topography, and streamflow depends heavily on ground water discharge, and surface and ground water basins do not necessarily coincide.

The proposed crossing of the Pit River is across Lake Britton (M.P. 687), a reservoir which is the site of an embankment and trestle supporting the present pipeline. Turbidity values for the Lake and most natural waters in the basin are low. No recent suspended-sediment data are available for the Pit River. The crossing is at a reservoir site.

Records for the Pit River near Canby, California, represent water-quality conditions near the proposed pipeline crossing. Quality is excellent: dissolved solids and hardness are low and a single observation for minor elements showed no arsenic, barium, cadmium, lead, mercury, or selenium. For the period 1965-71, maximum water temperature was 30.5°C; minimum, 0°C on many winter days.

South from the Pit River crossing, the proposed route crosses Burney Creek (M.P. 705), and then a number of small perennial streams that drain westward toward the Sacramento River across the south extension of the Cascade Range; Cow Creek (M.P. 711), South Cow Creek (M.P. 718), Snow Creek (M.P. 723), South Fork Bear Creek (M.P. 726), Shingle Creek (M.P. 728), Ash Creek (M.P. 732), North Fork Battle Creek (M.P. 734), Inks Creek (M.P. 740), Paynes Creek (M.P.743), and Salt Creek (M.P. 752). Several of these streams, such as the tributaries of Bear and Battle Creeks, are incised in deep bedrock canyons and consequently are crossed via overhead suspensions of the present pipeline. A fish hatchery is located on Battle Creek, upstream from the present pipeline crossing at M.P. 734.

Sacramento River Basin

The Sacramento River, the major stream of the northern Central Valley, is crossed by the route as it leaves cascade foothills 3 miles southeast of

Red Bluff (M.P. 755). Based on 93 years of record (1879-1972), mean discharge of the Sacramento River near Red Bluff is 11,650 cfs (Table 2.1.4.5-1). However, Shasta Reservoir has regulated a large part of the basin since 1943. The maximum discharge was 291,000 cfs (February 28, 1940), and the minimum was 2,000 cfs (March 29, 1944).

Sediment-transport characteristics of the river near Red Bluff are strongly affected by the high degree of regulation by Shasta Reservoir (Table 2.1.4.5-4). Ordinarily, sediment concentrations remain nearly constant from March or April until December; in the remainder of the year they are variable, with values as high as 300 to 1,000 mg/l typical of periods of moderate runoff and/or reservoir releases. On the average, about 40 percent of the suspended sediment is clay-size material.

Daily sediment data are available for the Sacramento River at Bend, six miles north of Red Bluff, for the period 1957-70. (Table 2.1.4.5-4)

At Bend, the Sacramento River water is low in dissolved-solids, soft, and low in turbidity. No arsenic, lead or selenium and only a trace of barium and cadmium were observed in a single sample. Maximum water temperature was 15.5° C on several days; minimum was 6.5°C, also on several days.

Benthic invertebrates, phytoplankton, and periphyton were collected by the U. S. Geological Survey in the Sacramento River at Red Bluff and at Colusa in 1972-73. Results show better quality of water at Red Bluff, where many Tricoptera, some Plecoptera, Ephemeroptera, Acarina, Crustaceans, and Annelids were taken. Diptera were found also, and consisted principally of Chironomidae in the subfamily Orthocladiinae and some Tipulidae. Presence of Orthocladiinae larvae generally indicate water that has adequate dissolved oxygen and firm substrate for invertebrate attachment where heavy silting of the streambed has not occurred. At Colusa, located about halfway between Red Bluff and Antioch, the Benthic invertebrate samples show only Diptera, some Annelids and rarely Crustaceans. The Diptera were of the Tribe Chironomini and family Chironomidae; usually these are found in waters that have little or no dissolved oxygen. One of the Crustaceans found was a brackish water species.

Diatoms were predominant in both the periphyton and phytoplankton samples with some green and blue-green algae. The amount of biomass for both periphyton and phytoplankton was much greater in the Colusa samples than in the Red Bluff samples.

As the proposed route traverses the west side of the Sacramento Valley southward toward Antioch, a number of streams are crossed that, with the exception of size and varying degrees of regulation, are generally similar in flow, sediment-transport, and water quality characteristics. For these streams, the average annual suspended-sediment yield ranges from less than 100 to more than 3,000 tons per square mile of basin area. Special attributes of this series of drainages, in contrast to those crossed on the northern part of the route, include: a) a great annual variation in yields from year to year--by a factor of as much as 50, and b) the transport of the great bulk of the sediment load during short intervals of flow. In most of the streams, 90 percent of the sediment is transported during only 3 percent of the time.

The ability of these ephermeral streams to transport large quantities of suspended-sediment at high concentrations is illustrated by the maximum daily concentration and load in 10 years of record (1962-72) for Thomes Creek (M.P. 767) at Paskenta -- 60,200 mg/l and 5,070,000 tons, respectively (both on December 22, 1964) (Table 2.1.4.5-4). Although this basin of 194

square miles is 15 miles west of the pipeline route, it is nevertheless similar in most characteristics to the drainages crossed directly by the route. The unusually high yield recorded at the Paskenta station (an annual average of more than 3,000 tons per square mile) is the result of unstable slopes formed on the highly erodible Franciscan Formation in the headwaters of the basin.

An example of a relatively large (737 square miles), highly regulated drainage is Stony Creek (M.P. 780). Prior to construction of Black Butte Dam in 1964, the maximum discharge of record (1955-72) was 36,300 cfs (February 24, 1958) (Table 2.1.4.5-1). After construction, maximum flow was 19,500 cfs (December 25, 1964). No flow occurred both prior and subsequent to construction of Black Butte Dam.

A channel-capacity study of Stony Creek downstream from Black Butte Dam included the reach crossed by the proposed pipeline route. Although somewhat modified due to effects of upstream dams, the general channel configuration probably is typical of the streams crossed by the route. The Stony Creek channel is only slightly incised between unstable banks composed of poorly sorted sand and gravel. Channel migration and diversion occur readily with overbank flow at medium discharges. The flood plain is poorly defined and, when overbank flow does occur, large areas of agricultural land may be inundated.

An example of a small (38.2 square miles) basin without known regulation or diversion is Stone Corral Creek (M.P. 815) near Sites. Mean annual flow is 5.3 cfs over 13 years of record (Table 2.1.4.5-1). The maximum recorded discharge is 2,640 cfs (January 29, 1968). There is no surface flow during most summer months and some entire years. Runoff from the basin is flashy, and in some instances is caused by summer thunderstorms.

The channels and depositional features of the smaller streams in the western Sacramento Valley, such as Stone Corral Creek, are typical of those of alluvial fans. The streams also have many of the characteristics of fan channels: flow is ephemeral, concentrations of suspended-sediment are high, much surface flow does not reach the trunk streams, and mudflows are not unknown. Southward from Stone Corral Creek other typical fan-forming streams are Spring Creek (M.P. 829), Whiskey Creek (M.P. 837), Salt Creek (M.P. 842), Petroleum Creek (M.P. 844), Mushoak Creek (M.P. 846), Buckeye Creek (M.P. 847), and North Fork and South Fork Creek (M.P. 852, 854).

The largest of the drainage basins crossed by the southernmost part of the route is Cache Creek--1,044 square miles above the gaging station near Capay, which is 3 miles upstream from the proposed pipeline crossing (M.P. 868). The mean annual flow over 30 years of record is 643 cfs (Table 2.1.4.5-1).

Sediment data are available for Cache Creek near Yolo (Table 2.1.4.5-4). Sediment yields vary greatly along the length of Cache Creek due to changes in sediment sources, channel characteristics, and factors related to land use.

Putah Creek (M.P. 824), crossed by the proposed route one mile west of Winters, is similar in most flow and sediment-transport characteristics to Cache Creek.

The proposed pipeline route terminates at Antioch after crossing the Sacramento and San Joaquin Rivers immediately upstream from their junction in the so-called delta area. The pertinent reaches of both rivers are strongly affected by tidal surge from the San Francisco Bay. Consequently,

the nearest meaningful flow data comes from stations long distances upstream--at Sacramento and at Vernalis, respectively, and do not apply to the crossing site. Extensive industrial use of this reach of the two rivers, and the presence of existing pipelines and flood-control works are both unique and more complex than at other crossings. The main stem of the Sacramento River, south from Sacramento, has one of the lowest unit sediment yields in the area; primarily because downstream tributaries are controlled and most sediment is trapped in reservoirs. Only 126 tons of sediment per square mile are produced, most of which (over 60 percent) consists of clay during periods of low flow. The San Joaquin River is similar--much of the runoff is impounded and sediment yields are low.

No biological data are available for the two crossings near Antioch. Here the bottom is soft, and the river receives a heavy load of industrial and municipal pollutants. If sampled, the benthic invertebrates collected would possibly contain worms such as polychaete Annelids and brackish water Crustaceans.

Groundwater

The following discussion of groundwater features follows the proposed 917-mile pipeline route from the vicinity of Eastport, Idaho, to the terminus at Antioch, California. The discussion is by successive physiographic provinces and sections.

Northern Rocky Mountains Province

Along the proposed pipeline route in the Northern Rocky Mountains province--from Eastport, Idaho, to the vicinity of Spokane, Washington--ground water occurs in two general ways and in two rock types: (1) unconfined water that circulates with relative freedom in alluvial valley trains; and (2) water in underlying crystalline rocks of igneous and metamorphic origins in which circulation is constrained largely to the zone of weathering and, at depth, to joints and other fractures. In general, the water is of the calcium bicarbonate type with dissolved solids less than 200 milligrams per litre (mg/l) and hardness from 75 to 150 mg/l. Much of the pipeline route follows the alluvial trains.

Those alluvial trains built by existing perennial streams generally are no more than a few tens of feet thick and are moderately permeable. In them, the water table stands in dynamic balance with the stream levels and so declines cross-valley to the stream except during and just after the yearly peak runoff of snowmelt. However, certain higher terraces along existing perennial streams such as the Spokane Valley plain and the contiguous Rathdrum Prairie to the east, are products of glacial age streams. Locally, these older alluvial deposits are known to be more than 200 feet thick and to be extraordinarily permeable. In them, beneath the Spokane Valley-Rathdrum Prairie district, ground water moves westward, at the rate of about 1,200 cubic feet per second (cfs). There, depth to the water table exceeds 100 feet extensively; also, water-table levels tend to respond to the stages of adjacent streams and other surface water bodies, although with considerable time lag.

The one large withdrawal of ground water in recent years has been from the older alluvial deposits to the east of Spokane, chiefly for municipal supply. Elsewhere, withdrawal from the alluvial deposits, both old and young, has been relatively small and probably much less than the potential sustainable yield. From the rocks, both actual recent withdrawal and potential yield appear to be small.

Columbia Plateau (Walla Walla Section)

Southwestward and southward from Spokane, Washington, the proposed pipeline route traverses the Walla Walla section of the Columbia Plateau province, to the vicinity of Bend, Oregon. Most of that reach (about 300 miles) is on upland which is dissected by the valleys of the Snake, Walla Walla, Columbia, John Day, and Deschutes Rivers. Ground water conditions are related to the land forms.

In this section, unconfined ground water occurs in alluvial valley trains of the perennial streams and, on intervening upland tracts, in the thinner of certain surficial deposits which are both discontinuous and of diverse rock types. Generally, in these situations, the potential ground water yields are small or moderate--sufficient for watering stock or supplying individual farmsteads, but insufficient for large or sustained withdrawals. Throughout the section, confined ground water occurs in the thicker of the surficial upland deposits, and in the basalt of the Columbia River Group which underlies virtually all the area, uplands and valleys alike.

The basalt is the regional aquifer of the Walla Walla section. It comprises many distinct flow layers, each commonly several tens of feet thick to about 100 feet; in the aggregate, its thickness is locally several thousands of feet. It is deformed extensively by gentle folds, locally by some faults which ordinarily are of small displacement and seemingly inactive.

Water in the basalt occurs largely in contact zones between flow layers or in fractures traversing to those layers; the greater part of the rock mass is virtually without pore space. Wells that penetrate but little into its saturated zone vary greatly in yield; thus, the basalt has been assumed to vary erratically in hydraulic conductivity. However, among wells that penetrate the saturated zone several hundred feet, the specific yields tend to increase in proportion to penetration. Thus, hydraulic conductivity of the basalt seems to be reasonably uniform.

Circulation of water in the basalt is influenced by the layering, or "stratification," of the rock and by the structural features which have been outlined. The potentiometric surface of water in the basalt stands as much as 1,000 feet beneath the highest uplands, but generally is above the level of the principal perennial streams. Also, that surface tends commonly to be trough-shaped beneath the valleys of those principal streams. Thus, regional circulation of ground water tends to be from uplands toward streams, with slow discharge into the streams seasonally.

Throughout the Walla Walla section, the basalt and thicker parts of the overlying surficial deposits sustain numerous large withdrawals of water for public domestic supplies and locally for irrigation. No records of volume withdrawn are available. The water is generally of the calcium bicarbonate type, with dissolved-solids and hardness ranging between 150 and 400 mg/l and 75 and 200 mg/l, respectively. The few data at hand suggest that the more concentrated waters have large contents of magnesium and sulfate ions.

Harney Section of the Columbia Plateau Province and Basin and Range Province

From the vicinity of Bend, Oregon, southward and beyond the Oregon-California boundary, the proposed pipeline route traverses the western fringe of the Harney section of the Columbia Plateau province and the Basin and Range province. For a length of about 150 miles, ground water

characteristics are largely inferred from those of the Harney Basin to the east.

In the northern part of the reach, unconfined water occurs in ash, pumice, and detrital deposits which floor the numerous ill-drained and undrained basins, and which are of small or moderate hydraulic conductivity. Depth of the water table below the land surface is expected to range from a few feet in the basin-center drainage sumps to 100 feet at basin peripheries. Concentration of this water ranges from about 100 mg/l to several hundred milligrams and calcium and bicarbonate are generally the dominant ions.

In the southern half of the reach, confined water would be expected in coarser-textured layers of the lake beds which form the uplands and underlie the basin floors. Regional circulation of this water is partly controlled by block faults. Anticipated dissolved-solids concentration would be approximately 100 to 250 mg/l, with sodium and bicarbonate as dominant ions. Static level of this water probably ranges from hundreds of feet below the highest upland tracts to land surface of the lowest basin plains. Thus, head may be sufficient for wells to flow locally. -In its deeper zones, the water may be thermal. The potential maximum yield of wells can be expected to be a few hundred gallons a minute. Present withdrawals are generally small and scattered.

Cascade-Sierra Mountains Province

South of the Oregon-California boundary, the proposed pipeline route angles across the Southern Cascade Mountains. Here occur the youngest volcanic rocks of the province--basaltic flows and cinders on the north and the extrusive and ejective rocks of Mt. Lassen on the south. Ground water conditions are inferred from the nature of the rocks, the rugged topography, and the climatic characteristics of the altitude range traversed.

Since much of the rock is fragmental ejecta or coarse-textured extrusive, presumably its hydraulic conductivity is moderate to large. The summit area being in the zone of large yearly precipitation, and of snowfall accumulation in winter, recharge is potentially large and doubtless exceeds infiltration capacity. Local relief being hundreds or even thousands of feet, depth of water table presumably ranges greatly. Dissolved-solids concentration of the ground water is anticipated to be from 100 to 200 mg/l, with calcium and bicarbonate the dominant ions. Present withdrawals are few and probably nominal in aggregate yearly volume.

California Trough Section

From the vicinity of Red Bluff, California, to its terminus near Antioch, the proposed pipeline route traverses the fluvial plain of the Sacramento Valley--that is, the northern segment of the California Trough section, Pacific Border province. Here, the shallowest ground water is unconfined and is little used. Depth to this water ranges from a few feet beneath the lowest parts of the plain to some tens of feet beneath the higher parts.

At depth, nominally confined water is tapped by thousands of wells, of which most are less than 250 feet deep, although a small percentage exceed 500 feet in depth. Yields are commonly several hundred gallons per minute per well. The water is generally of the calcium bicarbonate type, with dissolved-solids ordinarily less than 200 mg/l.

Natural circulation of this deeper water is generally from valley margins to valley axis, thence southward down valley. Rate of circulation varies greatly according to the heterogeneous texture of the fluvial valley fill in which the water is contained. Recharge is principally along valley margins by infiltration of rainfall and by percolation from perennial streams.

Although comprehensive and current data are not at hand as to rates and yearly volumes, much water is withdrawn from the deeper part of the valley fill, largely for extensive irrigation, but in part for public domestic supplies and other purposes. The resulting seasonal draw-down, which is substantial, accelerates the recharge by percolation from streams. Thus, present total recharge, and to some extent present patterns of circulation, are as much an effect of withdrawal as of natural features. Data at hand do not warrant a judgment as to present relative magnitude of withdrawal versus recharge.

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2.1.4.6 Vegetation

Major Plant Formations, Associations, and Communities

Vegetation on the 917 mile length of the proposed pipeline route from Kingsgate, British Columbia, to Antioch, California, will be discussed in order of magnitude; as plant formations, plant associations, and component plant communities. The proposed pipeline will cross the following four plant formations: 1) Prairie Grassland; 2) Desert; 3) Woodland-Bushland; 4) Coniferous Forest.

Plant formations, composed of plant associations, are separated by transitional zones, or ecotones. The plant associations also contain biological "islands" more characteristic of other associations. These "islands" result from changes in soil, geographical, climatic, altitudinal, and other variations within the association boundaries which are delineated on Figure 2.1.4.6-1. The location of plant associations in relation to pipeline miles is shown on Table 2.1.4.6-1.

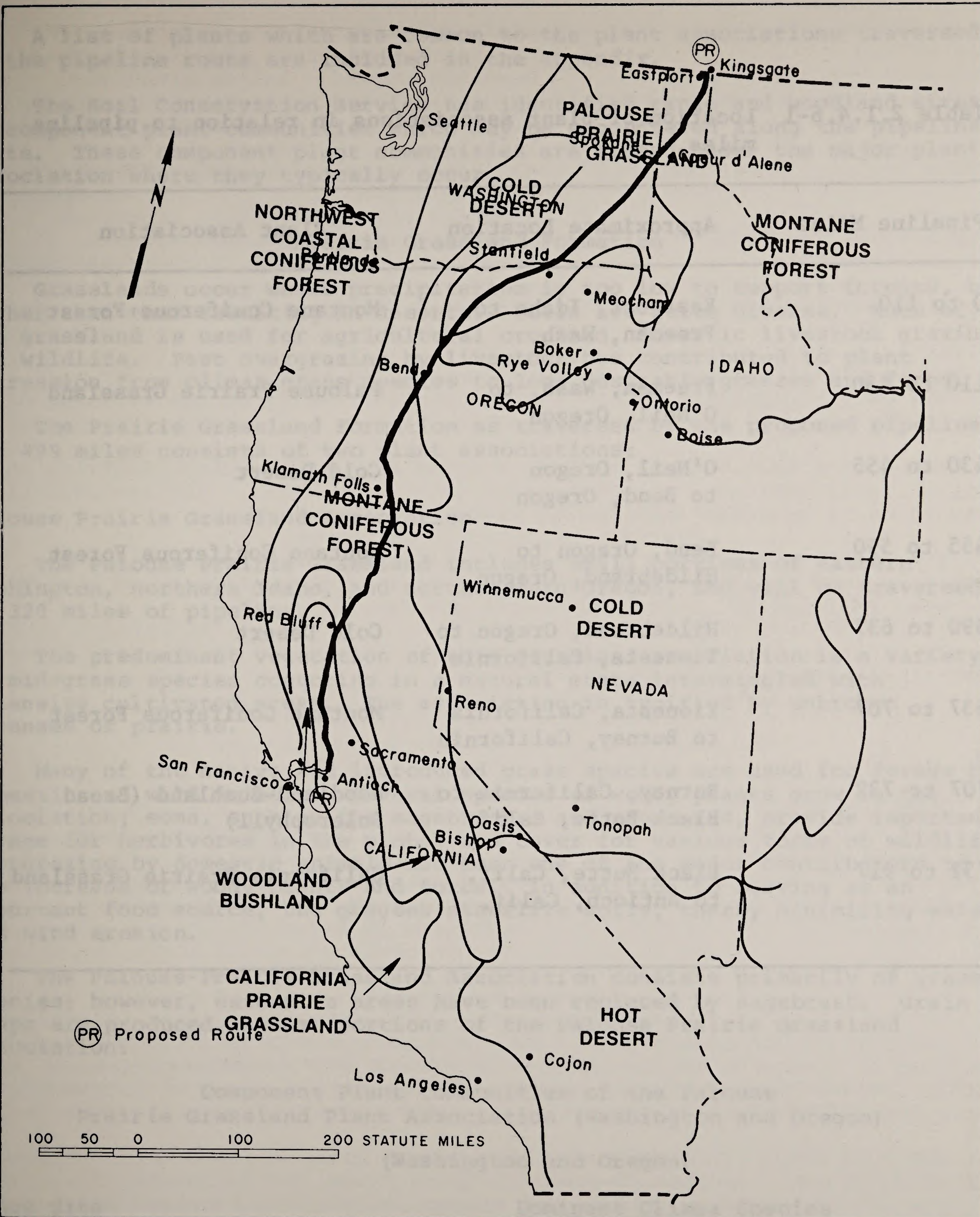


Figure 2.1.4.6-1 Plant associations of the western United States

Table 2.1.4.6-1 Location of plant associations in relation to pipeline miles.

Pipeline Miles	Approximate Location	Plant Association
0 to 110	Eastport, Idaho to Freeman, Wash.	Montane Coniferous Forest
110 to 430	Freeman, Wash. to O'Neil, Oregon	Palouse Prairie Grassland
430 to 455	O'Neil, Oregon to Bend, Oregon	Cold Desert
455 to 590	Bend, Oregon to Hildebrand, Oregon	Montane Coniferous Forest
590 to 637	Hildebrand, Oregon to Tionesta, California	Cold Desert
637 to 707	Tionesta, California to Burney, California	Montane Coniferous Forest
707 to 732	Burney, California to Black Butte, Calif.	Woodland-Bushland (Broad Sclerophyll)
732 to 917	Black Butte, Calif. to Antioch, Calif.	California Prairie Grassland

A list of plants which are common to the plant associations traversed by the pipeline route are included in the appendix.

The Soil Conservation Service has identified range and woodland sites as component plant communities which may be encountered along the pipeline route. These component plant communities are listed under the major plant association where they typically occur.

Prairie Grassland Formation

Grasslands occur where precipitation is too low to support forests, but higher than that resulting in deserts. Soils are quite diverse. Much of the grassland is used for agricultural cropland, domestic livestock grazing, and wildlife. Past overgrazing by livestock has contributed to plant regression from climax grass species to less desirable grasses and forbs.

The Prairie Grassland Formation as traversed by the proposed pipeline for 499 miles consists of two plant associations:

Palouse Prairie Grassland Association

The Palouse Prairie Grassland includes small portions of eastern Washington, northern Idaho, and northeastern Oregon, and will be traversed by 320 miles of pipeline.

The predominant vegetation of this grassland association is a variety of mid-grass species occurring in a natural state intermingled with extensive cultivated areas. The association is typified by unbroken expanses of prairie.

Many of the native and introduced grass species are used for forage by domestic and wild animals. Several species of woody plants grow in the association; some, such as the sagebrushes and sageworts, provide important forage for herbivores in the winter and cover for various forms of wildlife. Overgrazing by domestic animals has been one of the major contributors to the increase of woody plants and forbs. In addition to serving as an important food source, the grasses stabilize soils, therby minimizing water and wind erosion.

The Palouse-Prairie Grassland Association consists primarily of grass species; however, extensive areas have been replaced by sagebrush. Grain crops are produced in most portions of the Palouse Prairie Grassland Association.

Component Plant Communities of the Palouse Prairie Grassland Plant Association (Washington and Oregon)

(Washington and Oregon)

Range Site	Dominant Climax Species
Very shallow	Stiff sagebrush, Sandberg bluegrass
Deep upland	Bluebunch wheatgrass, Needleandthread
Sand (WA)	Bluebunch wheatgrass, Needleandthread
Loamy (6"-9")	Big sagebrush, Bluebunch wheatgrass
Loamy (9"-15")	Bluebunch wheatgrass, Idaho fescue
Loamy (15"-23")	Idaho fescue, bluebunch wheatgrass, Wyeth buckwheat
Shallow (9"-15")	Bluebunch wheatgrass, Sandberg bluegrass

Ponderosa Pine-grass	Idaho fescue
Sandy upland	Bluebunch wheatgrass, Needleandthread
Loamy Sand Terrace	Needleandthread - Indian ricegrass
Light Loamy Terrace	Needleandthread - Bluebunch wheatgrass
South Exposure	Bluebunch wheatgrass, Sandberg bluegrass
North Exposure	Idaho fescue, Bluebunch wheatgrass
Rolling hills	Bluebunch wheatgrass, Idaho fescue, Big sagebrush
Scabland	Sandberg bluegrass, rigid sagebrush
Shrubby south exposure	Bluebunch wheatgrass, Bitterbrush
Arid rolling hills	Bluebunch wheatgrass, Thurbers Needle-grass
Complex/rock outcrops	Bluebunch wheatgrass, Sandberg bluegrass

California Prairie Grassland Association

The California Prairie occupies the Central Valley of California and will be traversed by 179 miles of pipeline.

The predominant vegetation is a variety of grass species occurring in a rural state intermingled with extensive cultivated areas. The association is typified by unbroken expanses of prairie.

The California Prairie originally consisted of mid-bunch-grasses similar in form to those of the Palouse. Many of the native grass stands have been replaced by introduced annual grasses.

Overgrazing by domestic animals has been one of the major contributors to the increase of woody plants and forbs.

Component Plant Communities of the
California Prairie Grassland Association

Range Site	Dominant Climax Species
Clay pan	Softchess, filaree, blue oak, Wild oats, bur clover
Clayey	Wild oats, bur clover, softchess
Fine loamy	Softchess, wild oats, bur clover
Acid clay pan	Softchess, filaree

Desert Formation

Deserts are shrub-vegetated areas generally occurring in regions with less than 10 inches of annual precipitation and with marked extremes in weather. The vegetation is adapted to aridity, and bare earth is common; little humus is formed.

The Cold Desert Association of the Desert Formation extends throughout central Washington, eastern Oregon, southern Idaho, and northeastern California. It includes islands and fingers of grassland and woodland types. Parts of it are referred to as the High Desert or Great Basin Desert. The proposed pipeline will cross approximately 72 miles of the Cold Desert Association.

All desert vegetation has characteristic widely spaced distribution. Individual plants are thinly scattered and separated by large bare areas. The extensive bare ground, however, is not always free of plants. Mosses, algae, and lichens may form a stabilizing crust and function as nitrogen-fixing agents.

The cold desert is characterized by sagebrush, greasewood, shadscale, and saltbrush.

Unlike the grasslands and the forest, vegetative renewal in the desert is difficult and very slow.

The desert supports an extensive community of plants. Four life forms are common:

1) The annuals, which adapt to drought by growing only when moisture is adequate.

2) The succulents, such as the cacti, which adapt to drought by storing water.

3) The desert shrubs which have numerous branches originating from a short basal woody trunk, bearing small thick leaves that may be shed during prolonged dry periods.

4) Perennial grasses and forbs.

Component Plant Communities of the Cold
Desert Plant Association (Oregon)

Range Site	Dominant Climax Species
Shrubby rolling hills	Idaho fescue, Bitterbrush, Western Juniper
Juniper lavaland	Bluebunch wheatgrass, Idaho fescue, Western juniper

Woodland-Bushland Formations

The Woodland-Bushland plant formations generally occur as biological islands at higher elevations in the desert and grassland formations or in ecotones, or transitional zones, between the desert of grassland formations and the coniferous forest formation. Vegetative cover ranges from shrub species typical of the cold desert to brush and small tree species in areas of greater precipitation. A diversity of plant species and climatic conditions exists among the associations of this formation.

The Woodland-Bushland formation is in a transition stage. Woodland communities, particularly junipers, have invaded grassland and sagebrush sites, primarily due to overgrazing. This trend is expected to continue until land uses are modified to come into balance with climatic, site, and environmental factors. The proposed pipeline traverses approximately 25 miles of Woodland-Bushland formation in north central California.

Fire is an integral part of the woodland ecosystem. Under natural conditions, fire probably was the major factor in maintaining a balance between the woodland and adjacent plant communities. Changing land uses also have allowed woodland communities to expand. The Woodland-Bushland plant formation surrounds the California prairie grassland association.

The Woodland-Bushland formation is comprised of three plant associations:

Broad Sclerophyll Association

The Broad Schlerophyll (oak-chaparral) Association is best developed on the coastal ranges of southern California, but its range extends from southwestern Oregon southward through California's coastal mountains and the Sierra Nevada foothills into lower California. The association generally consists of trees or shrubs with hard, thick, evergreen leaves. The sclerophyll forest, woodland, and chaparral life forms merge with one another without forming distinct regions and with little or no plant succession relationship.

Chaparral is found in patches in most parts of the association and occupies the greatest area.

The sclerophyll forest generally occurs on north slopes. Scattered trees or woodland types occur with an understory of grass chaparral, or sagebrush.

Chaparral consists of shrubs which form dense thickets with little or no understory vegetation. It occurs on steep, loosely consolidated, highly erodible slopes.

Oak Bushland Association

The Oak Bushland Associations are scattered and generally occur as ecotones between the desert formation and pinyon-juniper association. The vegetation usually does not form a continuous cover, but occurs instead in dense clumps. In addition to oak, the vegetation generally consists of many species of deciduous shrubs. The composition of the shrubs is dependent upon elevation, topography, and aspect.

Pinyon-Juniper Association

The Pinyon-Juniper Association occurs in north-central Oregon at elevations between 3,000 and 7,000 feet. Stand density varies from a very few trees per acre to 600 or more per acre. An open stand is typical, but dense stands are not uncommon. Stands often thicken progressively from scattered trees at lower elevations to maximum densities just before the vegetation changes to timber or mountain shrub types. The lower, sparse stands frequently invade sagebrush or desert grass sites. The understory is comprised of mixed desert grasses and shrubs.

The herbaceous undercover varies inversely with the tree and shrub density. The shrub undercover decreases sharply where tree canopy exceeds 60 percent ground cover.

Component Plant
Communities of the Woodland-Bushland
Plant Association (California)

Range Site	Dominant Climax Species
Shallow loamy	Softchess, wild oats, filaree
Shallow cobbly loam	Softchess, wild oats, filaree
Loamy	Softchess, wild oats, filaree, bur clover

Coniferous Forest Formation

The Coniferous Forest contains a diversity of subregions, soils, resource products, and land uses. Annual precipitation in most of this formation is relatively high, and the forests have a great capacity for vegetative growth. The Coniferous Forest areas are used primarily for wood and water production and for recreation. Recreation is becoming an increasingly important use. In forested areas within weekend commuting distance from population centers, urban recreational developments are encroaching on some forested areas, especially where water-oriented sports can be enjoyed. Most of the Coniferous Forest land surface is Federally owned.

Montane Coniferous Forest Association

The Montane Coniferous Forest Association of the Coniferous Forest Formation covers the Selkirk Range in northern Idaho, Cascade Mountains in Washington and Oregon, and the Siskiyou Mountains in Oregon and the inner Coast Range and Sierra Nevada Mountains in northern California. They extend eastward to the woodland types of the Great Basin. The proposed pipeline will traverse 315 miles of Montane Coniferous Forest.

The dominant plant life form in this association are spruces, firs, and pines. The evergreens form a relatively continuous canopy over the forest floor. The dense, year-round shade often results in poor development of shrub, grass, and herb layers. Wood fiber productivity varies greatly in the Montane Coniferous Forests.

The composition of the forest vegetation is influenced to a large extent by elevation.

Natural forces such as bark beetles, defoliating insects, disease, and fire kill unusually high numbers of trees in some years. However, the outbreaks are part of a continuous cycle to which the Coniferous Forest Formation is adapted through rapid plant establishment and succession.

Timber has been, and is being, harvested in much of the Montane Forest Association. However, many sections of the Coniferous Forest are still in their natural state. The forest vegetation provides esthetic and recreational values and protects extensive watershed by stabilizing the soil. The vegetation also provides shelter, protection, and food for the many forms of wildlife.

Predominant species in the lower elevations of the Montane Forest are Douglas-fir, Engelmann spruce, ponderosa pine, lodgepole pine, and aspen. Subalpine and alpine areas in the higher elevations have dense interspersed stands of subalpine firs and Engelmann spruce. Understory vegetation is typically Pachistima.

Component Plant Communities of the Montane Coniferous Forest Plant Association

Range Sites	Dominant Climax
Loamy 16-20"	Idaho fescue, snowberry, bluebunch wheatgrass
Rolling hills	Idaho fesue, bluebunch wheatgrass, bitterbrush
Juniper rolling hills	Bluebunch wheatgrass, Idaho fescue, bitterbrush, thickleaf mohogany
Shrubby North exposure	Idaho fescue, Bluebunch wheatgrass, Klamath plume
Deep sand hills	Thurbers's needlegrass, Indian

	ricegrass, bitterbrush
Loamy	Bluebunch wheatgrass, Idaho fescue, big sagebrush
Shallow Hardpan	Low sagebrush, bluebunch wheatgrass, Idaho fescue
Very shallow loam	Low sagebrush, bluebunch wheatgrass, Sandberg bluegrass
Wet meadow	Tufted hairgrass, redtop, Nebraska sedge
Sodic semi wet meadow	Saltgrass, alkali sacaton
Shallow cobbly loam	Softchess, filaree, wild oats

Woodland Sites	Understory Vegetation
Mixed conifer	Ninebark, Pachistima, beargrass, buffalo berry
Western Hemlock	Pachistima
Douglas-fir	Pinegrass
Cedar Hemlock	Pachistima
Grand-fir	Pachistima
Western red cedar	Pachistima
Ponderosa pine	Snowberry, Thurbers needlegrass, bitterbrush, Idaho fescue, Ross Sedge, Western needlegrass, Ceanothus, Columbia needlegrass
Ponderosa pinegrass	Bluebunch wheatgrass, elk sedge, Idaho fescue, Elmer needlegrass
Pine - sedge	Ross Sedge, Western needlegrass, bitterbrush
Pine	Idaho fescue, bitterbrush
Pine - fir	Ross Sedge

Human Influences on Native Vegetation

Most of the land over which the proposed pipeline will be built has been affected by man's activities, beginning in the early nineteenth century.

Man's use of the land has affected the native vegetation in many forms; from the preservation of "natural areas" to diverse changes of vegetative types brought about by grazing, logging, and farming; and to complete denudation by flooding for hydroelectric, irrigation, and municipal water reservoirs and by industrial and urban development. A complete discussion of past and present land use is covered in Section 2.1.4.11.

Unique, Sensitive, and/or Threatened Ecosystems or Communities

No known unique, sensitive and/or threatened ecosystems or communities will be crossed by the proposed pipeline.

Terrestrial and Aquatic Species

Terrestial plant species in the four major plant associations are shown in the Appendix. No data are available on aquatic plant species which will be affected by construction of the pipeline.

Threatened and Endangered Species

The subject of threatened and endangered plant species has been researched in recent years by various agencies, universities and other groups.

Lists of such plant species are available from many sources and generally include plants that occur very sparsely in natural communities or are found in the outer limits of the plant's range..

While many of these species are unique when found in a certain geographic area they may be quite common in other areas.

The most comprehensive work on this subject is perhaps the Report on Endangered and Threatened Plant Species prepared by the Smithsonian Institution in 1974. This publication lists approximately 964 plants which are extinct, threatened, or endangered in Idaho, Washington, Oregon, and California.

The occurrence of threatened or endangered plant species along the proposed route is not known.

2.1.4.7 Wildlife

Dominant Wildlife Populations

Big Game Mammals

Six big game species are found on a 20 mile corridor along the proposed pipeline route. They are the white-tailed mule deer (including the black-tailed subspecies), elk, moose, pronghorn (antelope), black bear, and mountain lion. Most of the important habitats occur along its northern portion.

Deer are found all along the present right-of-way and there is a gradual shift in relative species abundance of deer; white-tails in the north, mule deer in the central portion, and black-tailed deer along the southern portion of the pipeline route. In the springtime, deer feed on the grasses and forbs growing on the existing right-of-way, especially in winter. The warmth from the natural gas heats the gound surrounding the pipeline, causing the snow to melt and exposing the palatable plants.

Wildlife winter ranges crossed by the pipeline include the Moyie River Valley for white-tailed deer and some moose, an area north of Sandpoint for mule deer, M.P. 117 to 122 for white-tailed deer, and the Snake River area for both mule and white-tail deer.

The area around Bend, Oregon is an important winter range for mule deer as well as a seasonal migration route. Other mule deer seasonal migration routes are found between La Pine and Crescent, and there is a mule deer winter range in the Lost River Valley in southern Oregon.

South of the California border mule deer winter in an area 10 miles south of the Lost River crossing and in the vicinity of Tionesta. Tionesta Valley provides spring, summer, and fall range for pronghorn but they move elsewhere for winter. North of Shingleton is an important summer range for black-tailed deer and a few elk, while around the Pit River there is a black-deer winter range. Finally, black-tailed deer live in low numbers on a year round basis on the pipeline route whenever it approaches the foothills of the Sacramento Valley.

Small Game

There are approximately 17 species classified as small game which may be found on the right-of-way corridor.

Rabbits and hares are present along the route; jackrabbits are found predominantly in sagebrush and grassland areas while cottontail rabbits tend to inhabit rimrock areas, forest, irrigated land, and river bottoms. Snowshoe hares live in the forested and woodland areas at higher elevations.

Tree squirrels are normally restricted to forested areas. Some of the larger ground squirrels are hunted for sport and may be found in the woodland-brushland, grassland, and high desert areas. The yellow-bellied marmot is found in rimrock areas along the pipeline route.

Fur-Bearing Mammals

Some 21 fur-bearing species of mammals, including coyote, skunks, mink, and weasels have been observed along the proposed pipeline route. Beaver and muskrat are found near streams and marsh areas. Forest areas contain lynx, marten, and fisher while lower vegetative area types contain bobcat and gray fox.

A variety of fur-bearers live near the Sacramento River crossings. Muskrats, beavers, and mink are found on Sherman Island.

Small Nongame Mammals

Nongame mammals are abundant and diversified throughout the region and make up the greatest category of mammals in both species (more than 40) and populations. Mice, rats, and moles are common in all areas. Ranges of ground squirrels, pikas, and chipmunks vary from sagebrush to forest habitats. Shrews inhabit damp or forested areas. Bats may be found in nearly all areas but are most abundant in grasslands and open forests.

Upland Game Birds

Upland game birds are relatively abundant within the region. Of the 12 species, 8 are native and 4 have been introduced.

The introduced upland game species include ring-necked pheasant, chukar, Hungarian partridge, and Merriam's turkey. The pheasant and Hungarian partridge are largely dependent on waste grains, weed seeds, and insects for food, and on brushy stream bottoms, ditch banks, and fence rows for winter and escape cover. Their distribution is limited to stream valleys which have sufficient water for crop farming and to adjoining nonfarmed areas.

Chukars were introduced in various locations. They inhabit the rougher canyonland breaks or similar topography.

Most of the Merriam's turkey introductions are generally found in the transitional zone between steppe vegetation and parklike forest. A very important turkey habitat exists where the proposed pipeline crosses the Sacramento River near Red Bluff.

Native upland birds are generally found in areas supporting indigenous forest and steppe vegetation. The forest grouse (ruffed, spruce, and blue

grouse) require open forest with abundant brushy areas of fruit-producing shrubs. Both the spruce and the blue grouse use the grassy openings of upper hill slopes, while the ruffed grouse remains close to the thick cover along streambeds and draws. Sharp-tailed grouse populations are restricted to areas covered by sagebrush and grass in the Palouse Prairie. Sage grouse are generally restricted to low sagebrush areas. Sage grouse wintering grounds occur along the proposed pipeline route in the desert near the Lava Beds National Monument (M.P. 635).

The Kootenai and Spokane River valleys contain pheasant, Hungarian partridge, California quail, blue, ruffed, sharp-tailed and sage grouse, and Merriam's turkey. Ptarmigan occur along mountain crests. Between the Spokane and Snake Rivers, both ring-necked pheasant and chucker partridge are abundant. Other species in this area include valley quail, chukar, sage grouse, and turkey. In the Umatilla River Basin, the ring-necked pheasant is the most numerous species, followed by California quail and chukar.

Waterfowl and Other Migratory Birds

There are in excess of 70 species of waterfowl and other migratory birds occurring along the proposed route. The marshes, low-gradient streams and rivers, natural lakes, and man-made reservoirs and irrigation ditches in Idaho, Washington, Oregon, and California are commonly used by ducks, geese, grebes, and some cranes and herons.

Lake Pend Oreille provides major resting and feeding habitat for waterfowl. Redhead and other diving ducks frequently winter on the lake.

Twenty-seven species of waterfowl visit the McNary Refuge near Wallula, Washington. Mallards, American wigeons, pintails, green-winged teal, northern varieties of the Canada goose, and whistling swans make up the bulk of the population during the fall months.

In the spring, waterfowl numbers again increase. Diving ducks like lesser scaup, buffleheads, canvasbacks, redheads, goldeneyes, and ring-necked ducks are common. Flocks of migrating dabblers include mallards, pintails, American wigeons, gadwalls, shovelers, and green-winged, blue-winged and cinnamon teal.

Goose nesting activity on the McNary Refuge commences in March and broods are usually seen in late April and May. Duck nesting occurs during April, May, and June with broods most commonly observed in June and July. Mallards and pintails are earliest nesters, and gadwalls and teal nest during late May and early June.

A great diversity of habitats is found in Oregon's Klamath Basin. It attracts a great variety of bird life. There are nearly 180 species of birds in the Basin including all the common dabbling and diving ducks, cackling, white-fronted, Ross', Canada, and snow geese, gadwalls, redheads, cinnamon teals, ruddy ducks, white pelicans, cormorants, gulls, terns, egrets, herons, grebes, avocets, stilts, and sandhill cranes.

Important waterfowl habitat occurs from south of Red Bluff to Antioch, California, and several National Wildlife Refuges lie 5 to 10 miles east of the proposed pipeline. The total waterfowl population may exceed two million by early January and include pintails, mallards, widgeon, and the snow, white-fronted and cackling geese. Seven great blue heron rookeries occur where the proposed pipeline crosses the Sacramento River near Antioch.

The distance from the existing pipeline to Grizzly Island waterfowl slough and marsh areas is four and one-half miles. Where the line crosses Sherman Island (between the Sacramento and San Joaquin Rivers) the waterfowl marsh area is two and one-half miles to the west. Waterfowl begin arriving in the marsh areas in August and peak in December.

Two other speciies of birds, the mourning dove and the band-tailed pigeon, occur along most of the proposed route. Both species migrate from summer ranges in Washington, Idaho, and Oregon to winter ranges in California.

Birds of Prey (Raptors)

There are more than 20 raptor species found along or near the proposed route. The turkey vulture, while not strictly a raptor, is listed in this functional group for convenience.

Many of these birds inhabit areas near bodies of water and in cultivated fields, steppe, grassland, and other areas with low vegetative cover.

Raptors use a broad aerial distribution in the region of the proposed project and several species occur along the entire pipeline route. Sherman Island, between the Sacramento and San Joaquin Rivers, hosts nesting marsh and redtail hawks. Osprey are known to nest around Lake Pend Oreille. The petroglyphs area near Newell, California, harbor many raptor nests, including prairie falcons. The pipeline will come within about four miles of this area.

Other Birds

Numerous other species of pasarine birds are found along the proposed route. No attempt has been made to describe their geographical distribution, habitat preference, abundance, or other ecological requirements of these species because of their number and diversity and in some instances because of limited knowledge of their characteristics.

Reptiles and Amphibians

The reptiles species known to occur along the proposed pipeline include 9 lizards, 15 snakes and 2 turtles. Although several species of snakes and lizards are widespread throughout the area, most species have specific habitat preference.

The amphibians are restricted to aquatic or damp habitats because they must lay their eggs in water and keep their skins damp to avoid desiccation. Approximately 15 species of salamanders, frogs, and toads are found along the proposed route.

Terrestrial Invertebrates

Common terrestrial invertebrates occurring along the route include worms, insects, spiders, mites, and less well-known groups of organisms. These organisms serve as food sources, decomposers, predators, herbivores, and disease vectors.

Two insects of considerable economic importance are the Tussock moth and the mountain pine bark beetle, both of which can kill vegetation. The Tussock moth infects Douglas-fir and, to a lesser extent, grand fir. The mountain pine bark beetle has infested significant areas of pine trees, especially lodgepole pine.

Aquatic Animals

Snails, most species of crustaceans, and numerous larval and adult insects are the dominant invertebrates occurring in the aquatic hatitats provided by reservoirs, marshes, creeks and rivers, and irrigation ditches along the proposed route. Aquatic invertebrates are important as a food source for higher animals, as disease vactors, decomposers, predators, and herbivores. For more detailed listings of aquatic invertebrates, refer to Section 2.1.4.5, Water Resources.

Fish

Aquatic biologists recognize two general fishery classifications: (1) cold water fishery usually indicated by the presence of salmonid species (salmon and trout); and (2) warm water fishery, often dominated by bass, crappie, and sunfish.

The Columbia-North Pacific region is especially noted for its salmonid species, particularly the anadromous forms, which have important commercial and sport fishery value. Many rivers and streams serve as spawning habitats for anadromous fish. These fish require exacting conditions for successful reproduction and survival: accessible streams, cool water, steady streamflow, minimal pollution, and suitable spawning substrata. Salmonid species in the region include chinook, coho, sockeye, chum, and pink salmon, Dolly Varden, steelhead, rainbow and cutthroat trout. Other anadromous fish present are white sturgeon, shad, and Pacific lamprey.

Most of the waters of the region where anadromous fish occur also support warm water fish. The main sport fish of this region, in addition to anadromous species, is stocked rainbow trout. Also, largemouth and smallmouth bass, crappie, yellow perch, channel catfish, and whitefish are stocked in suitable waters. Other species present are suckers, carp, northern squawfish, dace, chiselmouth, bullhead, and various shiners.

<u>Habitat Requirements and Limiting Factors of Major and/or Characteristic Animals</u>

Terrestrial Animals

Several arbitrarily defined communities comprise the terrestrial ecosystem (plant association) in and near the pipeline corridor. See Figure 2.1.4.6-1. Vegetative types determine the availability of suitable food, escape cover, breeding grounds, nest or den sites, and predator-prey and competitive interactions between species. Therefore, certain groups of animals are associated with particular vegetation types.

Vegetation-dependent animals such as small birds, rodents, snakes, frogs, and numerous invertebrates tend to have small territories or home ranges and they do not usually leave the vegetation-type community. Some are restricted to certain vegetation types because they are food-specific; for example, beavers, squirrels, and martens. Other animals are completely dependent on some characteristics of the community; for example, sage grouse

require strutting grounds in relatively open steppe, and often quail depend on brush near creeks for cover. Many wildlife require riparian habitats during at least some phases of their life cycle.

Some animal species are not restricted to certain vegetation types, but instead range over large areas or general vegetative communities. These animals are adapted to varied conditions and can live in many habitats even though individuals tend to remain in small areas. For example, although common garter snakes occur in most of the different habitats along the route, each individual snake probably remains in a relatively restricted area. Other animals such as deer, elk, larger birds, and larger carnivores have relatively extensive ranges and therefore utilize several vegetation types in their activities.

Large mobile or migratory species are influenced by seasonal weather variations. These animals tend to move from one vegetative community to another during the year. For instance, deer and elk move from the higher coniferous forests of their summer range to lower coniferous forest, steppes, or agricultural communities in winter where snow cover is not so deep and food is more plentiful. Some species of birds, especially ducks, geese, shorebirds, and several species of songbirds, are migratory and remain for only short periods to rest and feed along their migratory routes.

Aquatic Animals

Several large rivers such as the Columbia and Sacramento Rivers and their major tributaries dominate the regions crossed by the proposed pipeline route. (See Section 2.1.4.5.) During the last century, major changes have occurred in these rivers. These changes have influenced species composition and productivity of the aquatic systems. The most significant of these changes include:

Construction of dams and reservoirs on most of the major rivers and many of their tributaries

Seasonal dewatering section of the rivers for irrigation

Addition of nutrient loads from municipal sewage, irrigation return water, and industrial discharge

Addition of silt loads from logging and agricultural practices

Blockage of streams from improper logging practices

Addition of toxic materials

Adverse effects from these physical and chemical changes include:

Blockage of large sections of streams to migratory fish

Alteration of spawning grounds from free-flowing to reservoir-types habitats

Drastic increase of undesirable fish such as suckers and carp and decrease of sport and commercial species.

Decrease in primary and secondary productivity of the aquatic habitat

Destruction of vital riparian wildlife habitat

Occasional nitrogen supersaturation resulting in fish death

Severe losses and destruction of some anadromous fish, primarily salmon and steelhead, have resulted from construction of numerous dams on most of the major streams crossed by the proposed pipeline. The alteration from free-flowing streams to reservoirs has increased the production of warm water game fish species. Proliferation of many undesirable species such as squawfish, suckers, and carp has occurred at the expense of game fish. Despite varied adverse effects, many highly productive aquatic habitats remain within the region. Fish and wildlife for recreation and food production have been substantially reduced by human activities.

Unique, Sensitive, Threatened and/or Endangered Species

The wildlife species listed in Table 2.1.4.7-1 are those species which state governments have expressed concern. They may or may not have been formally classed in various categories of concern. The list does not include all of the rare and/or unusual species found along the proposed route. Official lists are constantly being expanded and revised. The status of many species is uncertain and still under study. Other taxons of animals not listed in this report also contain species that are rare and potentially endangered. However, at the present time these groups are less well known than the more visible mammals, birds, reptiles, amphibians, and fishes. An example is the land mollusks with rare or "potentially" endangered species identified in the following counties of California that would be crossed by the pipeline: Siskiyou - 11 species, Tehama - 1 species, Solano - 1 species, and Contra-Costa - 4 species. These mollusks are found in a wide range of terrestrial habitat including stone outcroppings, organic debris, and live vegetation of various types.

Endangered Species

Table 2.1.4.7-2 lists species formally classed as endangered by the Federal Government that occur along the pipeline route.

The Northern Rocky Mountain wolf probably does not occur along the pipeline route. However, there was a verified specimen taken near Baker, Oregon in early 1974.

The peregrine falcon generally ranges above the existing pipeline. One known peregrine eyrie lies very close to the pipeline in California.

Four known active bald eagle nesting territories are located on Britton Reservoir (Pit River) within 2.5 miles of the existing pipeline crossing (M.P. 686); one of these is within sight of the crossing. These nests are close to the 41st Parallel and it is questionable as to whether these are southern bald eagles (an endangered species) or northern bald eagles. Nest locations are: section 12, T. 36 N., R. 3 E; section 2 and 28, T. 37 N., R. 3 E. Nesting territories extend from 0.5 miles east of the existing pipeline to 0.5 miles west of the state highway bridge over Britton Reservoir.

The Aleutian Canada goose winters in the San Joaquin Valley of California and has been identified at several locations in Western Washington and Oregon during migratory flights. Banded individuals have been found at the Sacramento and Colusa National Wildlife Refuges and flocks of 300-350 birds have been recorded.

Table 2.1.4.7-1 Unique, sensitive, threatened and/or endangered species that may occur along the proposed pipeline route.

Common Name	Specific Name	Remarks
Mammals		
Mountain caribou	Rangifer tarandus caribou	Formally wintered near Moyie River. Could be introduced.
California bighorn sheep	Ovis canadensis californicus	Being reestablished in Central Washington and Northern California mountains
Grizzly bear	Ursus horribilis	May occur in Northern Idaho
Northern Rocky Mountain wolf	Canis lupus irremotus	May occur in Northern Idaho, Eastern Oregon and Washington
Mountain lion (cougar)	Felis concolor	Occurs rarely along entire route
White-tailed jackrabbit	Lepus townsendii	Occurs in SE Washington part of route
Pygmy rabbit	Sylvilagus idahoensis	Occurs in SE Washington part of route
Kit fox	Vulpes macrotis	Occurs in desert areas of Southeast Oregon and in California
Wolverine	Gulo gulo	Occurs rarely in forested areas near Bend, Oregon, and Shasta Co., California
Ord's kangaroo rat	Dipodomys ordii	Occurs in Southern Washington-expanding population
Spotted bat	Euderma maculatum	May occur in Klamath Co., Oregon
Fisher	Mortes pennanti	May occur in mountains near Burney, Calif. and adjacent locations. Requires isolated habitat.

Table 2.1.4.7-1 (cont.)

Common Name	Specific Name	Remarks
Pine Martin	Mortes americana	May occur in mountains near Burney, Calif. Verified in adjacent locations. Requires isolated habitat
Canada lynx	Lynx canadensis	May occur in wild uninhabited areas
Birds		
Northern bald eagle	Haliaeetus leucocephalus alascanus	Nests in Klamath Basin, Oregon, along route. Generally declining.
Southern bald eagle	Haliaeetus leucocephalus leucocephalus	Nests in Shasta County, Calif., along route
Aleutian Canada goose	Branta canadensis leucopareia	Winters in Sacramento River Valley, Calif.
Tule White-fronted goose	Anser albifons gambelli	An occasional migrant
Osprey	Pandion haliaetus	Nests in Northern Idaho (M.P. 60), Central Oregon, & Northern Calif. (M.P. 680). Uses Big Lake, Tule Lake, Eastman Lake and associated watercourses
Prairie falcon	Falco mexicanus	Nests in Southeastern Washington and North Central Oregon in crags and cliff-side aeries
Peregrine falcon	Falco peregrinus	Occurs in Southeastern Washington along route
Spotted owl	Strix occidentalis	Occurs in Central Oregon along route in deep forests

Table 2.1.4.7-1 (cont.)

Common Name	Specific Name	Remarks
Yellow-billed cuckoo	Coccyzus americanus	Occurs in dense plant habitat of Sacramento River, crossing near Red Bluff, May through September
Reptiles and Amphibians		
Giant garter snake	Thomnophis couchi gigas	Occurs in fresh water marsh areas near Antioch, California
Shasta salamander	Hydromantes shastae	Restricted to limestone caves and outcrops of Mt. Shasta. Not on corridor
Fishes		
White sturgeon	Acipenser transmontanus	Kootenai River, Idaho and Snake River, Wash.
Thicktail chub	Gila crassicauda	Rare in Sacramento River Delta, California.
Lost River sucker	Catostomus luxatus	In lakes along Oregon-California border
Shortnose sucker	Chasmistes brevirostris	In lakes and streams along Oregon-California border
Rough sculpin	Cottus asperrimus	In Pit River, Shasta County, California
Inverterbrates		
10 species	Family Tenebrionidae	Restricted to sand dune areas near Antioch, California
10 species	Family Meloidae	
30 species	Family Lepidoptera	

Source: Vicksburg U.S. Army Engineers Waterways Exp. Sta. Tech. Rep. M-74-6.

Table 2.1.4.7-2 List of Federal endangered species.

State	Common Name	Scientific Name	Comments and Areas of Special Concern
Idaho	Peregrine falcon	Falco peregrinus	Ranges above much of the entire route.
Washington	Peregrine falcon	Falco peregrinus	Ranges above much of the entire route. Known to nest and feed along Snake River, in general area where pipeline crosses.
Oregon	Peregrine falcon	Falco peregrinus	Ranges above much of the entire route.
	Northern Rocky Mountain wolf	Canis lupos irremotus	A recent (1974) confirmation of a Northern Rocky Mt. wolf killed near Baker, Oregon suggests this species may again occur in remote areas in the state.
California	Peregrine falcon	Falco peregrinus	At least one recently active eyrie is located very close to the pipeline.
	Southern bald eagle	Haliaeetus leucocephalus leucocephalus	Ranges over pipeline south of 40th parallel. Several active nest sites within 5-10 miles of pipeline near Clayton, California.
	Aleutian Canada goose	Branta canadensis leucopareia	Banded individuals found at Sacramento and Colusa National Wildlife Refuges adjacent to proposed pipeline.

Source: U.S. List of Endangered Fauna, May 1974, USDI.

2.1.4.8 Ecological Considerations

Previous sections describe in detail the climate, topography, soils, geology, vegetation, water, wildlife, and land uses that will be traversed by the pipeline.

All of these ecological components are interrelated. No one component can be adequately analyzed without considering the effects of other components on it.

The purpose of this section is to discuss briefly the basic ecological processes that have created the present conditions previously described.

Major Ecosystems

Living organisms and their nonliving environment are inseparably interrelated and interact upon each other. The ecosystem is the basic functional unit in that relationship. Ecosystems may be conceived of and described in various sizes. So long as the major biotic and environmental components are present and operate together to approach functional stability, the entity may be considered an ecosystem. Thus, the entire forest may be considered as an ecosystem or the smallest temporary pond, even though its existence is limited to a relatively short time period, may be a functioning ecosystem.

The major natural ecosystem types along the pipeline route generally coincide with the major vegetation associations described in Section 2.1.4.6. The mixed-coniferous forest, grassland, desert, woodland and the floodplains are readily identifiable terrestrial ecosystems. Streams, lakes and wetlands constitute the aquatic ecosystems along the pipeline route. Each of these major ecosystems contains a unique combination of plant and animal communities having its own food chain, energy circuit, nutrient cycle, environmental elements and pattern of development and evolution.

As with plant units the major ecosystems may be defined in terms of smaller units within the larger delineation. This report will consider only the larger ecosystems. As previously indicated 917 miles of the proposed pipeline traverses extensive areas of natural plant communities. These figures do not include those small scattered natural ecosystems such as floodplains and wetlands. Nine hundred seventeen miles or 100 percent of the proposed pipeline will cross areas where man has modified the original ecosystem through intensive agriculture or construction of the existing pipeline facilities.

Since man and his livestock have become permanent biotic factors responsible for almost complete alteration of the original ecosystems, it is difficult to describe agricultural lands as natural ecosystems. Although the major elements of an ecosystem are present they are artificial in nature. Man changes the environment through drainage, plowing and grazing. He annually plants and harvests his crops and applies fertilizers to replace nutrients. However, even under these conditions many new ecosystems develop that support new plant and animal communities.

Grasslands

The proposed pipeline route traverses approximately 499 miles of Palouse and California prairie lands. Many of the native and introduced species are used for agricultural crops or forage for domestic and wild animals. The grasses help stabilize soils, minimize water and wind erosion.

The existing rangelands are generally composed of those sites where soils, rainfall and topography have created severe limitations for agricultural use.

Where soils are light textured and shallow the potential plant communities are dominated by perennial mid-grasses and a few tall grasses including Little bluestem, Big bluestem, Needleandthread and a variety of scattered perennial forbs and shrubs. The heavier clay soils are usually dominated by perennial grasses such as Western wheatgrass. These sites also contain a variety of perennial forbs and a few shrubs.

When disturbance occurs in the mixed-grass prairie, i.e., heavy grazing, the dominant tall and mid-grasses tend to diminish and are replaced by short grasses and mid-grasses of lower palatability. These may include various combinations of blue grama, western wheatgrass, dryland sedges and the less palatable perennial forbs.

With severe overuse the plant communities will deteriorate to sparse stands of short grasses and invading annual plants that usually expose the soil to erosion.

The mixed grass prairie through which the pipeline route passes is presently in fair to good condition.

In terms of forage production the rangelands through which the proposed pipeline passes are producing more than 50 percent of their potential.

As the producer elements of the ecosystem change because of consumer activity a new balance must be achieved so that energy inputs and comsumption of food material are again in a state of equilibrium. The level and diversity of wildlife populations are related to these range conditions where over half of the range is in fair to good condition. On this grassland type, with its extremes of climate, the cover provided by the limited areas of brush in the gullies and brush and trees along the stream courses is a critical element of the prairie ecosystem. These cover areas are also shared with livestock so that forbs used by wildlife as food are heavily cropped by livestock and the quality of cover is reduced as livestock use opens up these areas.

Portions of the route are now cultivated with an artificial one-crop ecosystem, where fields are planted to wheat or left fallow in alternate years. Wildlife cover in the form of fencerows, hedgerows and uncultivated areas is limited in the dry farming areas. With a limited variety of wildlife foods and the absence of cover many of the wildlife species which once flourished in the grassland type find it more difficult to thrive in these areas.

Desert Type

The proposed pipeline route crosses approximately 72 miles of the cold desert subregion of the desert. It does not traverse the hot desert.

The desert type generally is composed of site conditions where soil and water limitations restrict plant development. The desert is characterized by sagebrush, rabbitbrush and various grasses; all of which have low palatability but help reduce wind and water erosion.

The extensive bare ground is not always free of plants. Mosses, algae, and lichens form a stabilizing crust and function as nitrogen-fixing agents.

When disturbance occurs in the desert type, i.e., heavy grazing or construction, the vegetation renewal is difficult and slow. After disturbance, the plants that generally return are low producing annual species.

The desert type vegetation through which the pipeline route passes is presently in fair condition and is producing forage in excess of fifty percent of its potential.

As the producer elements of the ecosystem change because of man's activities a new balance must be achieved between the energy inputs and consumption of food material, until both are again in a state of equilibrium.

The level and diversity of wildlife populations are related to these changing conditions where the desert vegetation is in fair condition. Wildlife species and populations then must be in balance with the limited food and cover available in the desert type. These species include such animals as deer, coyote, cottontail and jack rabbits, a variety of small rodents and song birds.

Woodland-Bushland

The California-bushland is a fairly contiguous community occurring as an ecotone between California grassland type and the forest type. The ecological interrelationships of the woodland-bushland are closely related to those of the adjacent vegetative types.

Other woodland-bushland ecosystems can be found as biological islands within the grassland and desert types. Again, since these vegetative types are in transition stages the interrelationships closely relate to those of the adjacent types.

The proposed pipeline route crosses about 25 miles of the woodland-bushland type in northcentral California. The vegetative characteristics are similar to the cold desert. It is characterized by oak, chaparral and juniper. The vegetation helps to reduce water and wind erosion. The woodland-bushland generally is composed of steep, loosely consolidated, highly erodible slopes.

Grassland and sagebrush sites are invaded by woodland, particularly junipers, primarily due to overgrazing. Fire probably is the major factor in maintaining a balance between the woodland and adjacent plant communities.

The woodland-bushland through which the pipeline route passes is producing forage and browse for domestic livestock and wildlife. The wildlife population and species must be in balance with the limited food and cover available similar to that discussed in the desert type.

Coniferous Forest

The proposed pipeline route traverses about 315 miles of the coniferous forest vegetation. Precipitation is high, and generally there is adequate moisture for maximum production of the living components. The forest watershed is a primary source of water flowing through plant communities at lower elevations.

The dominant plant life form in the coniferous forest consists mainly of spruces, firs, and pines. Composition is influenced to a large extent by elevation. The heavy shade throughout the year limits development of the understory. Moderate amounts of soil organisms occur.

The coniferous forest, generally occurs on moderate to steep slopes and often on unstable and erodible soils.

Physical disturbance occurs in the coniferous forest, i.e., logging Such disturbances usually cause increases in stream temperatures and sediment concentrations, which can affect the aquatic ecosystems. The aquatic communities in this vegetative type are complex and diverse. Anadromous fisheries are dependent upon the forest watershed.

The coniferous forest through which the pipeline route passes is presently in good to excellent condition. It is producing more than 80 percent of its production potential.

Fire is an important ecological factor in the forest watershed, since it can destroy a stabilized habitat by removing the predominant forest cover and create new biological communities. Favorable climatic conditions generally enhance rehabilitation and natural successional plant and animal recovery in the forest ecosystems.

Ecosystem Productivity

The primary productivity of an ecosystem is defined as the rate at which radiant energy is stored by photosynthetic or chemosynthetic activity of producer organisms (green plants) in the form of organic substances which can be used for food.

In grassland ecosystems the common unit of primary productivity is pounds of air dry forage per acre per year. Annual wood production indicates primary productivity in the coniferous forest ecosystems. Major factors influencing the productive capability of an ecosystem include availability of water and nutrients and length of growing season. In northern Idaho, eastern Washington, and central Oregon, where growing seasons are relatively short and precipitation limited, the grassland type may produce 500-1,000 pounds of air dry forage per acre. The grasslands in California may produce as much as 2,000 pounds because of more favorable precipitation and longer growing seasons.

Fluctuations in climatic conditions from one year to the next result in significant annual variations in forage production. Prolonged droughts cause dramatic decreases in production that disrupt normal farming and ranching operations.

In general the primary factors affecting terrestrial ecosystem productivity also affect aquatic ecosystem productivity. Of course, the loss of water from an aquatic system would destroy that ecosystem. Of course, the loss of water from an aquatic system would destroy that ecosystem. However, in years of more favorable climatic conditions the ecosystem will produce more food material than in less favorable years.

As previously stated, it is difficult to treat agricultural lands as true ecosystems. Man has been able to increase productivity through elimination of the original ecosystem and establishment of a cultural ecosystem. High productivity in crops is maintained through large energy inputs involved in cultivation, fertilization, irrigation and insect control. These energy supplements are generally derived from fossil fuels

and are replacing or supplementing the solar energy of the original ecosystem.

In terms of food produced per unit of energy expended, the natural ecosystem is more efficient than the cultured ecosystem.

Ecosystem Interrelationships

The conversion of solar energy to organic food material by living plants is only one stage in the complex interrelationships between living organisms and the environment that constitutes the ecosystem.

The transfer of food energy from plants through a series of organisms with repeated eating and being eaten constitutes the food chain.

In the grazing food chain the green plant is eaten by the herbivore and the herbivore is eaten by the carnivore. At the same time dead organic matter is assimilated by microorganisms which are eaten by detritivores which also have predators.

With each step in the food chain there is a loss of energy. This loss of energy is offset by energy converted by the plant from the sun so the system continues to function in a state of dynamic equilibrium.

Although species and environmental conditions differ, these processes occur in both the aquatic and terrestrial ecosystems.

There are interrelationships between ecosystems. For example, the aquatic system of a north Idaho lake might depend upon the surrounding forest watershed for nutrients and water draining off the land surface. Birds and other animals that nest on the lake feed in the forest and surrounding land. Predators remove animals or fish from the lake to the land. Watering herbivores fertilize the lake with their droppings. Migratory waterfowl make seasonal use of aquatic environments over wide areas, but may feed on adjacent agricultural lands where food is available.

These facts are important in evaluating impacts of the proposed pipeline. The disturbance of one ecosystem may indirectly affect the equilibrium of other ecosystems.

Ecosystem Parameters and Critical Factors

As vegetation develops, the same area becomes successively occupied by different plant communities. This process is termed plant succession.

If a bare field is left to natural processes, a sequence of plant communities will occur starting with annual plants adapted to the bare field environment, and culminating in the original climax plant community.

Likewise if a pine forest is cleared and then returned to nature a succession of plant communities will occur; grassland, grass shrub, mixed forest and ultimately the climax coniferous forest. This process may require over 100 years.

A mature climax ecosystem is one where the producer organisms (plants) are in the ultimate stage of succession allowed by the physical environment and the annual production is in balance with annual consumption and energy flows.

Man has been a primary influence responsible for alteration of the original climax ecosystems. When a stable community is maintained by man or his domestic animals in a stage of development below climax, it is called a disclimax.

Applying these principles to the proposed pipeline route the following conditions are evident:

In the mixed grassland type some overgrazing has produced disclimaxes or regression of successional stages of plant communities. Here livestock have replaced many of the native herbivores and have consumed more food than the system could annually replace. The result is a lower plant community producing more short grasses than mid-grasses and consequently a lower annual production. Through grazing management the trend can be reversed and a climax ecosystem can be reestablished.

In the grassland regions the climax plant community has virtually disappeared to provide man with the rich agricultural lands found along the pipeline route in Idaho, Washington, Oregon, and California.

Generally in the coniferous forest along the pipeline route the climax tree species have been harvested. Today these timber stands are in lower successional stages and, if undisturbed, will ultimately reach climax.

Where cultural ecosystems have resulted in annual commercial crop production, the remnants of natural plant communities become the critical factors in maintaining diversity in terrestrial animal populations.

The diversity of aquatic animal populations is also related to remnants of undisturbed aquatic environments.

Factors which have affected these natural aquatic environments include siltation, pollution from commercial, residential, industrial and agricultural wastes, channelization, stream obstruction and inundation from reservoirs.

Unique Ecosystems

No unique ecosystems are present within the proposed pipeline right-of-way.

2.1.4.9 and 10 Social and Economic Factors

The proposed route passes through 26 counties in four states. The economic environment varies considerably along the course of the proposed route. For convenience in description of the economic and social features, the route has been divided into four areas which have some degree of economic and geographic homogeneity. These have been designated for this purpose as the Spokane-Palouse Hills area, the Columbia Basin area, the Oregon Plateau-Northern California Mountain area, and the Central Valley area. These description areas, and their relationships to the proposed pipeline route, counties, and states are shown in Figure 2.1.4.9-1, Socio-economic base map.

The following description of economic and sociological features of the proposed pipeline route is based on the counties through which the route would actually pass.

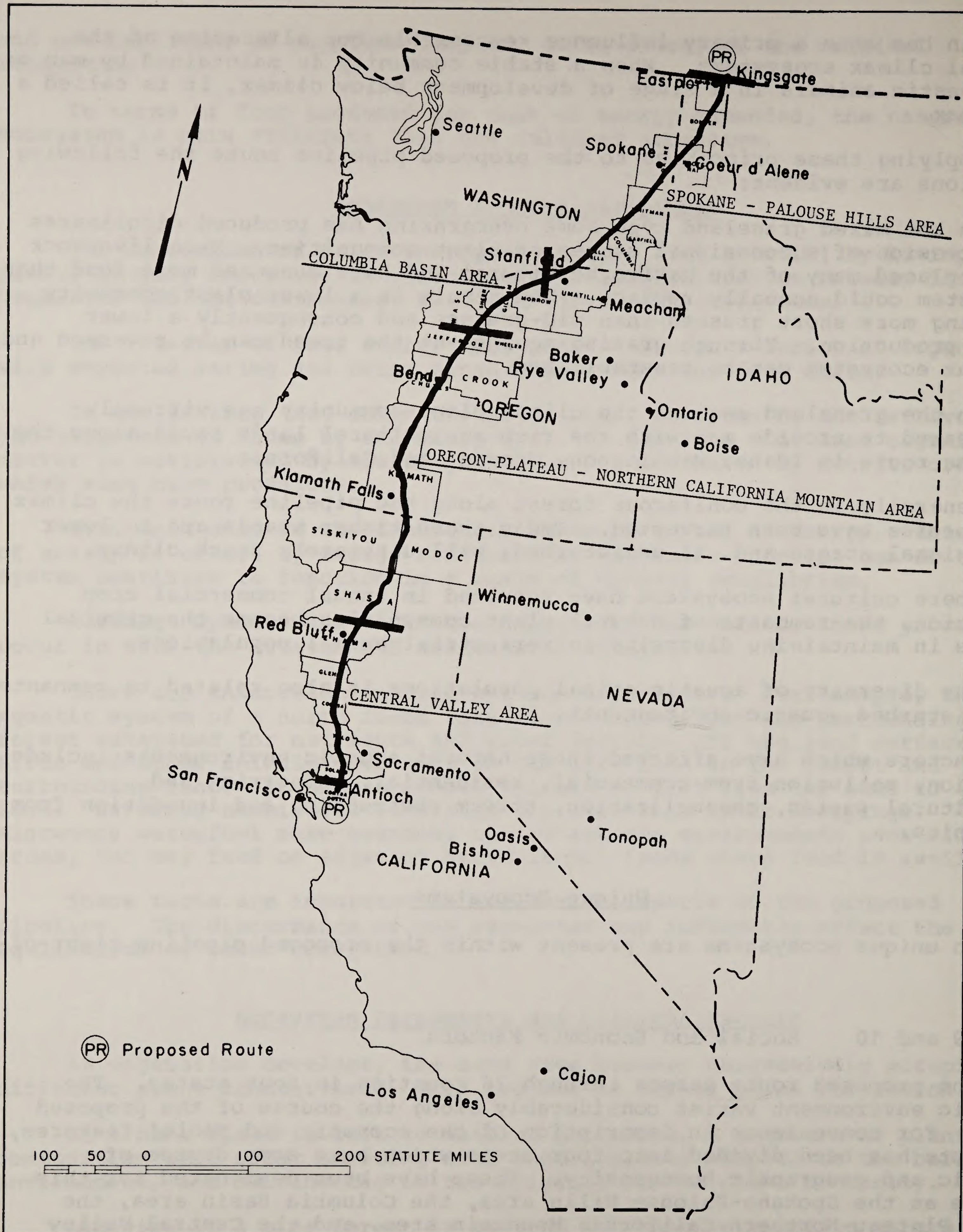


Figure 2.1.4.9-1 Socio-economic base map

One of the principal features of this pipeline construction proposal is that it would parallel an existing pipeline for all but 21 miles of the route and is essentially a looping of the existing line.

History of Economic Development and Principal Economic Activities

Spokane-Palouse Hills Area

The city of Spokane is the center of economic activity in this area, and in fact of a much larger intermountain area. It began as a sawmill town utilizing water power of the Spokane River, became a transportation center with the arrival of the Northern Pacific Railroad and later three other railroads, and a supply center for the Coeur d'Alene mining district in northern Idaho. Its biggest surge in development came with establishment of wheat farming in the Palouse Hills to the south and irrigation along the Columbia River to the east. It is presently the marketing, trading, finance, and service center for the large wheat and cattle raising, mining, and lumbering area of eastern Washington and western Idaho. It has developed manufacturing industry based on the availability of hydroelectric power (Grand Coulee Dam), minerals, lumber, wheat, and cattle. These include aluminum refining and casting, wood mill work, meat packing, flour milling and storage, manufacture of railroad rolling stock, and paper. Three colleges and universities are located here.

The three Idaho counties in the north end of this area, while sparsely populated are less rough and inaccessible than central Idaho, with more economic activity--centering around lumbering, mining, recreation, and tourism.

The area south of Spokane is the Palouse Hills, low, rounded dome-like hills 20-100 feet high that were formed by windblown silt. This is very fine textured soil with a high moisture absorbing and retaining capacity that is the foundation for a very productive dry land wheat producing farm area. Three-quarters of the harvested cropland is wheat which is alternated every other year with summer fallow to conserve the scarce moisture. Farms in this area are relatively prosperous.

Columbia Basin Area

The Columbia Basin area is part of an extensive dry land wheat farming area. The soil and rainfall are not as favorable as in the Palouse Hills area, but because farms are relatively large--1,300 acres--family incomes in the area are high. Crops are produced only in alternate years on each piece of land. The area is cut by deeply eroded canyons. Pendleton, Oregon, the largest city in the area, is specialized in shipping wheat and cattle and canning peas. It is also a furniture and woolens manufacturing center.

Oregon Plateau-Northern California Mountain Area

The Oregon portion of this area is a large semi-desert region with limited agriculture and lumbering. The principal economic activity is grazing cattle and sheep on the sparce desert vegetation. The northern California counties are a low population density mountainous region. Lumbering is the principal source of employment. It is also a recreation area for people from the more populated area to the south.

Central Valley Area

This is the northern half of California'a great central valley. Agriculture is the principal economic activity of this area with products consisting mainly of cereals such as rice, barley, and wheat. This area also produces fruit and vegetables, but not to the extent that they are produced in the southern half of the valley. Livestock grazing and dairy farming takes place on the rougher valley sides. Farm incomes are generally high.

The Sacramento metropolitan area is the capital city of the state of California, a Pacific coast deep water port, a major processor of the agricultural produce of the central valley, and a warehouse and rail transportation center. It was the center of the early gold mining activity. Military establishments have been important in the economy of Sacramento.

The San Francisco-Oakland metropolitan area is the largest and most diversified seaport on the Pacific coast. In addition it is a major mining, real estate, finance, manufacturing, and commercial center of the West coast.

Population, Employment and Income

Two tables of data describe the socio-economic environment of each area along the pipeline. Population in the counties traversed by the pipeline is shown in Tables 2.1.4.9-1, -3, -5 and -7. Other socio-economic data are in Tables 2.1.4.9-2, -4, -6, and -8.

The data contained in these tables indicate that there are population and economic activity concentrations in the areas at both the north and south end of the proposed route with much smaller populations in the areas in between. The major concentration of population and activity is, of course, in the San Francisco-Sacramento metropolitan areas, at the southern end of the route, which are the major markets to be served by the proposed pipeline.

The 26 counties through which the pipeline would pass had a total population of 2-1/4 million people in 1970. This was about 9 percent of the total population of the four states, California, Idaho, Oregon, and Washington, and only 1 percent of the Nation's population.

Spokane-Palouse Hills Area

The Spokane-Palouse Hills area which encompasses the northern one-third of the proposed route had a population of nearly one-half million in 1970, about 21% of the total for the route. More than 60 percent of these people live in the Spokane metropolitan area. Population density is higher here than any other area along the route except the Central Valley Area but still little more than one-half of the nation's population density. The rate of population growth in the decade of 1960-70 was 5 percent, a little more than one-third the national average during that period. Only two counties in the area experienced an actual decline in population, and these were the most rural counties in the area. The rate of urbanization for the area is about the same as the national average, but, again, concentrated in the Spokane area. The minority population is very low, being only 1 percent in Spokane and Walla Walla Counties and less in other counties of the area (see Table 2.1.4.9-1).

Table 2.1.4.9-1 Population summary, Spokane-Palouse Hills area; 1950, 1960, 1970.

	Actual					Urban			Rural	
County	1950	1960	1970	%-Chg 60-70	Pop/Sq Mile 1970	1970	% of Total	%-Chg 60-70	1970	%-Chg 60-70
(United States)			203,212,877	13.3	57	149,361,464	73.5		53,851,413	
(California)		15,717,204	19,957,715	21.7	128	18,141,562	90.9		1,816,153	
(Idaho)		667,191	712,567	6.9	9	386,924	54.3		325,643	
(Oregon)		1,768,687	2,091,385	18.3	22	1,403,319	67.1		688,066	
(Washington)		2,853,214	3,409,169	19.6	51	2,475,057	72.6		934.112	
(11 Western States)	19,561,114	27,193,698	33,737,365	24	29	28,070,978	83	32	5,666,387	-5
Bonner, Idaho	14,853	15,587	15,560	0	9	4,144	27	-5	11,416	2
Boundary, "	5,908	5,809	5,484	-6	4	2,796	51		2,688	-54
Kootenai, "	24,947	29,556	35,332	20	28	16,228	46	14	19,104	25
Umatilla,Oreg.	41,703	44,352	44,923	1	14	22,195	49	-3	22,728	6
Columbia,Wash.	4,860	4,569	4,439	-3	5	2,596	58	-11	1,843	11
Spokane,Wash.	221,561	278,333	287,487	3	164	246,261	86	5	41,226	-5
Walla Walla, Wash.	40,135	42,195	42,176	0	33	30,969	73	8	11,207	-18
Whitman, Wash.	32,469	31,263	37,900	21	18	23,173	61	47	14,727	-5
TOTAL, Spokane-Palouse Hills Area	386,436	451,664	473,301	5	35	348,362	74	8	124,939	-2

Source: Census of Population, 1970.

Table 2.1.4.9-2 Salient socio-economic data for counties traversed, Spokane-Palouse Hills area, 1970.

	Idaho			Washington				Oregon
	Boundary County	Bonner County	Kootenai County	Spokane County	Whitman County	Columbia County	Walla Walla County	Umatilla County
Civilian labor force	2,152	5,533	13,006	107,328	14,281	1,868	16,840	17,596
Percent unemployed	12.1	12.6	9.6	6.9	3.5	10.0	6.5	7.1
Percent employed in industry								
Manufacturing	21.4	20.9	22.4	12.5	3.1	19.2	9.5	15.7
Wholesale, retail trade	20.7	21.8	22.0	25.4	15.7	15.9	19.7	20.6
Services	7.7	6.5	8.7	9.4	5.9	4.5	7.8	5.9
Educational services	7.4	7.1	7.1	9.5	37.2	4.2	16.9	8.3
Construction	7.1	7.7	8.4	5.6	3.5	6.2	8.0	5.8
Government	22.0	19.1	16.0	16.1	42.8	17.3	24.8	23.0
Median family income (1969) ($)	7,681	7,559	8,295	9,456	9,099	8,466	9,490	8,638
Per capita income (1969) ($)	2,478	2,450	2,705	3,015	2,785	2,855	3,040	2,795
Year-round housing units - 1970	2,164	5,920	12,962	99,439	11,456	1,766	14,488	15,999
Rental vacancy rate (%)	9.4	9.4	10.0	7.2	4.0	21.4	8.3	9.7
County general revenue (1967) ($ million)	2.5	3.2	6.6	67.3	8.4	1.8	10.8	15.2
Property taxes ($ per capita)	208	124	90	85	79	102	95	174

Table 2.1.4.9-2 (cont.)

	Idaho			Washington				Oregon
	Boundary County	Bonner County	Kootenai County	Spokane County	Whitman County	Columbia County	Walla Walla County	Umatilla County
Retail estab. (1967)	61	198	405	2,174	313	66	388	489
Sales ($ thousands)	6,739	20,753	48,306	473,000	48,313	7,893	73,481	83,149
Service estab. (1967)	45	124	294	1,761	179	42	278	309
Receipts ($ thousands)	501	2,276	6,106	70,681	4,149	498	6,607	7,186
Wholesale estab. (1967)	7	29	42	621	84	20	100	80
Sales ($ thousands)	1,739	5,196	13,085	675,239	53,797	9,343	72,528	45,406
Farms (1969)	308	502	522	2,076	1,468	258	800	1,284
Value of farm prod. sales (1969) ($ thousands)*	3,152	2,991	5,577	22,814	47,805	9,648	35,267	53,867
Distribution of sales (%) Crops								
Crops	42.9	9.4	59.1	57.3	83.7	91.6	67.1	37.8
Dairy products	15.9	33.7	11.1	11.9	0.4	**	1.2	1.0
Livestock & products	35.4	49.5	24.5	17.0	15.5	8.0	29.7	59.6
Poultry & products	***	0.8	2.1	13.4	0.3	0.1	1.9	1.3

*For farms with sales of $2,500 and over.
**Not reported to avoid disclosure.
***Less than 0.05 percent--represents zero.

Source: County and City Data Book, 1972.

Table 2.1.4.9-3 Population summary, Columbia Basin area; 1950, 1960, 1970.

	Actual					Urban			Rural	
County	1950	1960	1970	%-Chg 60-70	Pop/Sq Mile 1970	1970	% of Total	%-Chg 60-70	1970	%-Chg 60-70
11 Western States	19,561,114	27,193,698	33,737,365	24	29	28,070,978	83	32	5,666,387	-5
Morrow, Oregon	4,783	4,871	4,465	-8	2		0		4,465	-8
Gilliam, Oregon	2,817	3,069	2,342	-24	2		0		2,342	-24
Sherman, Oregon	2,271	2,446	2,139	-13	3		0		2,139	-13
Wasco, Oregon	15,552	20,205	20,133	0	8	10,423	52	-1	9,710	0
TOTAL, Columbia Basin Area	25,423	30,591	29,079	-5	4	10,423	36		18,656	

Source: Census of Population, 1970.

Table 2.1.4.9-4 Salient socio-economic data for counties traversed, Columbia Basin area, 1970

	Oregon			
	Morrow County	Gilliam County	Sherman County	Wasco County
Civilian Labor Force	1,749	782	831	7,820
Percent Unemployed	7.0	3.7	2.9	6.7
Percent Employed in Industry*				
Manufacturing	10.2	.9	3.3	15.8
Wholesale; retail trade	20.2	16.1	23.2	21.8
Services	4.6	6.4	5.2	6.8
Educational Services	5.5	16.2	14.1	8.1
Construction	3.6	5.4	13.6	11.2
Government	18.8	28.3	22.7	21.5
Agriculture and Fisheries	35	28	29	9
Median Family Income (1969) $	8,425	8,220	8,513	9,025
Per Capita Income (1969) $	3,071	2,625	2,638	2,877
Year-Round Housing Units-1970	1,746	942	870	7,127
Rental Vacancy Rate (%)	11.5	14.2	11.5	11.7
County General Revenue (1967) ($ million)	2.4	1.2	1.2	7.0
Property Taxes ($ Per Capita)	303	234	215	161
Retail Establishments (1967)	75	42	39	220
Sales ($ thousands)	6,803	5,324	2,465	42,927
Service Establishments (1967)	32	21	19	165
Receipts ($ thousands)	471	204	205	4,513
Wholesale Establishments (1967)	11	11	12	44
Sales ($ thousands)	5,050	4,734	5,244	23,864
Farms (1969)	347 (2.7)	166 (-10.8)	209 (-9.5)	542 (-15.6)
Value of Farm Prods. Sales (1969) ($ thousands)**	9,420	6,378	4,705	10,895
Distribution of Sales (%)				
Crops	60.8	58.7	78.8	70.6
Dairy Products	2.7	--	--	.7
Livestock and Products	35.8	41.2	21.2	27.9
Poultry and Products	****	****	****	.3

*May not add to 100 due to exclusion of white collar workers and double counting of government employees.
**For farms with sales of $2,500 and over.

Source: County and City Data Book, 1972.

Table 2.1.4.9-5 Population summary, Oregon Plateau-Northern California Mountain area; 1950, 1960, 1970.

County	Actual					Urban			Rural	
	1950	1960	1970	%-Chg 60-70	Pop/Sq Mile 1970	1970	% of Total	%-Chg 60-70	1970	%-Chg 60-70
Jefferson, Oregon	5,536	7,130	8,548	20	5		0		8,548	20
Crook, Oregon	8,991	9,430	9,985	6	3	4,101	41	26	5,884	-5
Deschutes, Oregon	21,812	23,100	30,442	32	10	17,431	57	14	13,011	66
Klamath, Oregon	42,150	47,475	50,021	5	8	31,521	63	14	18,500	-6
Siskiyou, California	30,733	32,885	33,225	1	5	8,377	25	-23	24,848	13
Shasta, California	36,413	59,468	77,640	31	20	38,519	50	30	39,121	32
Modoc, California	9,673	8,308	7,469	-10	2	2,799	87	-1	4,670	-15
TOTAL, Oregon Plateau-No. Calif. Mtn. Areas	155,308	187,796	217,330	15	8	102,738	47		114,582	

Source: Census of Population, 1970.

Table 2.1.4.9-6 Salient socio-economic data for counties traversed, Oregon Plateau-Northern California Mountain area, 1970.

	Oregon				California		
	Jefferson County	Crook County	Deschutes County	Klamath County	Modoc County	Siskiyou County	Shasta County
Civilian Labor Force	3,553	4,069	12,391	18,745	3,092	12,543	29,110
Percent Unemployed	5.7	7.6	6.7	6.9	5.7	10.1	12.1
Percent Employed in Industry*							
Manufacturing	10.6	32.7	20.8	21.0	8.8	22.4	17.2
Wholesale; retail trade	28.9	18.8	22.6	23.2	19.8	19.9	23.1
Services	6.5	5.4	9.0	6.1	7.5	7.5	9.1
Educational Services	8.8	6.5	7.9	8.6	6.4	7.5	9.0
Construction	4.8	3.4	8.0	5.3	5.8	6.6	7.3
Government	22.2	15.7	14.8	17.6	28.3	19.1	21.5
Agriculture and Fisheries	19	14	6	10	26.0	11.0	5.0
Median Family Income (1969) $	8,549	8,287	8,939	8,645	8,473	8,963	9,108
Per Capita Income (1969) $	2,618	2,749	2,985	2,912	2,867	2,930	2,949
Year-Round Housing Units-1970	2,945	3,586	11,201	17,944	2,827	12,717	27,302
Rental Vacancy Rate (%)	13.6	4.0	7.8	7.4	10.2	10.2	6.9
County General Revenue (1967) ($ million)	3.6	3.1	9.2	14.2	4.4	16.9	41.0
Property Taxes ($ Per Capita)	205	149	152	139	197	179	208
Retail Establishments (1967)	105	103	376	528	93	472	852
Sales ($ thousands)	16,611	11,876	53,275	83,549	9,327	52,728	133,579
Service Establishments (1967)	67	71	281	352	65	294	686
Receipts ($ thousands)	1,251	1,792	5,549	10,065	43.1	6,716	18,596
Wholesale Establishments (1967)	19	11	65	81	18	51	130
Sales ($ thousands)	11,669	8,553	32,465	42,488	9,723	22,080	120,639
Farms (1969)	356 64-69(-9.8)	293 (-35.1)	503 (-35.1)	826 (-8.5)	483 (-8.5)	671 (-6.3)	746 (-10.6)
Value of Farm Prods. Sales (1969) ($ thousands)**	19,267	9,060	6,367	27,049	16,834	17,123	7,293
Distribution of Sales (%)							
Crops	47.9	24.3	30.0	39.6	45.3	45.1	21.5
Dairy Products	.2	1.9	17.3	3.7	.3	5.2	11.8
Livestock and Products	51.9	71.9	40.8	54.6	54.4	48.1	61.8
Poultry and Products	****	1.4	11.9	1.2	.1	****	.9

*May not add to 100 due to exclusion of white collar workers and double counting of government employees.

**For farms with sales of $2,500 and over.

Source: County and City Data Book, 1972.

Table 2.1.4.9-7 Population summary, Central Valley area; 1950, 1960, 1970.

	Actual					Urban			Rural	
County	1950	1960	1970	%-Chg 60-70	Pop/Sq Mile 1970	1970	% of Total	%-Chg 60-70	1970	%-Chg 60-70
Tehama, California	19,276	25,305	29,517	17	10	11,249	38	10	18,268	21
Glenn, Calif.	15,448	17,245	17,521	2	13	6,969	40	4	10,552	0
Colusa, "	11,651	12,075	12,430	3	11	3,842	31	9	8,588	-
Yolo, Calif.	40,640	65,727	91,788	40	89	69,829	76	54	21,959	8
Solano, California	104,833	134,597	169,941	26	206	158,089	93	48	11,852	-58
Sacramento, California	277,140	502,778	631,498	26	648	600,474	95	41	31,024	-59
Contra Costa, California	298,984	409,030	558,389	37	762	522,618	94	58	35,771	-54
TOTAL, Central Valley Area	767,972	1,166,757	1,511,084	30	168	1,373,070	91		138,014	
TOTAL, All Regions	1,335,139	1,836,808	2,230,794	21	39	1,834,593	82		396,191	

Source: Census of Population.

Table 2.1.4.9-8 Salient socio-economic data for counties traversed, Central Valley area, 1970.

	California						
	Tehama County	Glenn County	Colusa County	Yolo County	Solano County	Sacramento County	Contra Costa County
Civilian Labor Force	10,906	6,780	4,768	36,334	54,326	244,280	223,383
Percent Unemployed	9.1	5.2	3.4	7.0	7.7	7.1	5.5
Percent Employed in Industry*							
Manufacturing	25.1	9.8	17.2	8.6	20.6	9.3	20.6
Wholesale; retail trade	18.6	20.0	8.9	18.2	20.4	21.3	20.3
Services	7.7	6.0	8.8	7.2	7.3	7.7	7.7
Educational Services	7.1	5.8	5.5	22.7	8.3	8.8	8.8
Construction	5.2	5.7	20.7	5.3	4.9	6.2	7.3
Government	17.6	17.4	20.0	36.3	37.8	35.2	19.6
Agriculture and Fisheries	13.0	29.0	33.0	8.0	4.0	2.0	1.0
Median Family Income (1969) $	8,470	8,308	9,257	9,482	9,878	10,561	12,422
Per Capita Income (1969) $	2,831	2,782	3,214	2,990	3,091	3,391	3,965
Year-Round Housing Units - 1970	10,363	6,211	4,646	29,665	53,460	212,157	178,329
Rental Vacancy Rate (%)	5.5	8.6	9.1	5.6	4.7	6.1	4.7
County General Revenue (1967) ($ million)	12.6	9.9	9.7	32.7	62.6	277.4	252.7
Property Taxes ($ Per Capita)	188	217	360	190	129	181	242
Retail Establishments (1967)	340	217	185	675	1,196	4,681	3,588
Sales ($ thousands)	44,534	29,967	25,601	122,808	247,959	1,070,555	836,909

*May not add to 100 due to exclusion of white collar workers and double counting of government employees.

Table 2.1.4.9-8 (cont.)

	California						
	Tehama County	Glenn County	Colusa County	Yolo County	Solano County	Sacramento County	Contra Costa County
Service Establishments (1967)	232	142	93	519	799	3,641	2,912
Receipts ($ thousands)	4,571	2,539	1,604	16,227	27,970	160,338	91,666
Wholesale Establishments (1967)	25	28	19	112	125	729	324
Sales ($ thousands)	17,929	36,229	14,399	125,833	63,173	932,548	463,661
Farms (1969)	1,266	1,218	632	927	868	1,642	1,022
	(-9.9)	(-7.2)	(5.2)	(7.7)	(-.9)	(-6.7)	(-23.7)
Value of Farm Prods. Sales (1969) ($ thousands)**	22,404	39,708	47,750	65,237	38,171	52,555	32,193
Distribution of Sales (%)							
Crops	45.6	65.8	88.9	93.7	70.4	57.6	47.5
Dairy Products	7.2	12.0	1.2	.3	4.8	12.5	.2
Livestock and Products	44.8	20.3	7.0	5.8	23.5	21.6	44.9
Poultry and Products	2.3	1.8	2.9	.2	1.4	8.0	.4

**For farms with sales of $2,500 and over.

Source: County and City Data Book, 1972.

The unemployment rate in this area is generally higher than the national rate, ranging from 50 percent greater in Spokane County to nearly three times as high in the northern Idaho counties. The employment data of Table 2.1.4.9-2 reflect the agricultural and lumbering orientation of this area's economy. Manufacturing employment is well below the national average of 25.9 percent. In Spokane County only 12.5 percent of the labor force was engaged in manufacturing occupations. Only in the northern Idaho counties does manufacturing approach the national level. Most counties in the area tend to have a higher level of employment in government than does the nation generally. Agriculture thus dominates the economy of this area and with the exception of Bonner County, Idaho cash crop farming dominates the agricultural activity. The Palouse Hills area is a very productive wheat growing area.

Per capita incomes are below the national average throughout this area, ranging from 79 percent to 97 percent of the national average. The highest incomes are in the most urban counties, Spokane and Walla, Walla, Washington.

Columbia Basin Area

This is the smallest of the four areas of the proposed pipeline route. Total population in 1970 was 29,079, just 1 percent of the four area total (see Table 2.1.4.9-3). This is a rural, agricultural area with only 36 percent of the population living in urban centers, the lowest portion of any area along the route, and these are concentrated in one county of the area. This area experienced a 5 percent decline in population between 1960 and 1970, which is another indication of its rural character. Population density was just four persons per square mile for the entire area with two counties having only two persons per square mile. The minority population of the area is nil and population from foreign stock is below the national average.

The rate of unemployment in 1970 was about 50 percent higher than the national average except in the two most agricultural counties (see Table 2.1.4.9-4). Agriculture is the basic element of the economy. Employment in manufacturing is very low with only half the national portion of the labor force so employed in even the most industrialized county of the area. Farms are generally larger--two to three times larger than farms in the Palouse Hills area to the northeast but of lower productivity. Cash grain farm operations predominate.

Per capita incomes are lower here, little more than 90 percent of the national average.

Oregon Plateau-Northern California Mountain Area

This area comprises more than one-third of the length of the proposed route, but its 1970 population of 217,330 was only 10 percent of the total population of the four areas along the route. Population density in the area averages eight persons per square mile and ranges as low as three in one county and as high as 20 in one county (see Table 2.1.4.9-5). Population in the area increased 15 percent between 1960 and 1970 which is faster than the national average. The minority portion of the population is low with less than 1 percent of the population of the area being black. The portion of the population defined as of foreign stock is also well below the national average. The portion of the population that is urban dwelling is 47 percent, well below the national average of 74 percent.

Agriculture and forestry provide the economic base of the area. Employment in manufacturing is well below the national average. The unemployment rate is considerably higher. Agriculture is much more specialized in livestock raising than in the two regions to the north (see Table 2.1.4.9-6).

Per capita incomes are slightly below the national average at about 95 percent of the national level.

Central Valley Area

The Central Valley area is by far the largest of the four areas along the proposed route although it encompasses less than one-quarter of the length of the proposed pipeline. Its population in 1970 was 1-1/2 million people, 68 percent of the total population of the 26 counties along the proposed route (see Table 2.1.4.9-7). This population is more than 90 percent urban, well above the national average. Ninety percent of the population of the area live in the three metropolitan counties of Contra Costa, Sacremento, and Solano. Population density of the area averages 168 persons per square mile, three times the national average density, and ranges up to 762 persons per square mile in Contra Costa County. This has also been a rapidly growing area with a 1960-1970 rate of increase of 30 percent, well over twice the national rate of growth for that period. The minority element of the population is about the same as the national average with about 10 percent of the population black.

This is the most industrialized area along the route with about 20 percent of the labor force engaged in manufacturing, compared to the national average of 26 percent (see Table 2.1.4.9-8). Government employment is a specialty of the area with every county having more than the national share of its labor force working in government and several of the larger counties having double the national share of its workers in government employment.

Agriculture remained an important portion of the economy in this area with field crops the major source of agricultural income. The overall unemployment rate in the area in 1970 was 25 to 75 percent higher than the national unemployment level.

Incomes in this area are higher than anywhere else on the proposed route. Average per capita income is above the national average. In Contra Costa County, per capita income was more than 25 percent above the national average in 1969. Median family income was 30 percent above the national average.

Local Tax Structures

Table 2.1.4.9-9 shows total county general revenues and expenditures as well as per capita revenues and expenditures. The per capita expenditure levels can be used, comparatively, as a rough measure of community services capacity. That is, in counties where per capita expenditure is relatively low in any category, it may reasonably be inferred that the counties' facilities or services are fully committed to present use. Higher per capita expenditure for services in the more populous counties reflects not only the higher cost of providing services under denser population conditions but also a tendency of larger communities to offer a broader range of services to their citizens. Education is the major expenditure of local government with shares of total expenditure ranging, from an unusually low 16 percent in Modoc County, California to 85 percent in Yalo County,

Table 2.1.4.9-9 County tax and selected expenditures, 1967.

Item	Spokane Palouse Hills Area							
	Bonner Idaho	Boundary Idaho	Kootenai Idaho	Spokane Wash.	Whitman Wash.	Columbia Wash.	Walla Walla Wash.	Umatilla Oregon
General Revenue (Thous. $)	3,154	2,458	6,593	67,324	8,385	1,765	10,788	15,230
from Property Taxes	1,879	1,080	2,839	22,289	2,579	488	4,045	7,788
General Expenditures (Thous. $)	3,316	1,711	6,506	67,326	7,583	1,769	10,895	14,689
Per Capita Amounts								
General Revenue	208.88	472.67	209.32	255.79	258.00	367.64	253.24	339.95
from Property Taxes	124.45	207.60	90.14	84.69	79.36	101.67	94.94	173.83
General Expenditures a/	219.62	329.04	206.54	255.80	233.33	368.54	255.76	327.88
on Education	133.71	126.36	116.94	147.32	143.64	151.93	143.64	213.94
on Highways	34.11	55.84	31.41	27.73	34.84	82.17	36.13	28.37
on Hospitals	--	--	--	3.04	--	47.40	.82	28.43
on Police Protection	7.84	7.68	7.56	11.90	7.74	7.46	8.41	9.38
on Sewage	1.81	.81	2.90	3.32	2.23	5.98	3.67	4.44
on Parks and Recreation	1.28	--	2.32	6.96	3.59	3.11	5.47	2.49
on Housing and Renewal	--	--	--	--	--	--	.23	1.25

a/ Will not add since detail is not complete.

Table 2.1.4.9-9 (cont.)

Item	Morrow Oregon	Gilliam Oregon	Sherman Oregon	Wasco Oregon	Jefferson Oregon	Crook Oregon	Deschutes Oregon	Klamath Oregon	Siskiyou Calif.	Modoc Calif.	Shasta Calif.
	Columbia Basin Area				Oregon Plateau - Northern California Mountain Area						
General Revenue (Thous. $)	2,380	1,238	1,201	6,886	3,608	3,139	9,159	14,192	16,946	4,358	41,045
from Property Taxes	1,302	608	602	3,552	1,864	1,503	4,198	6,904	6,207	1,475	15,685
General Expenditures (Thous. $)	1,981	1,794	1,238	6,505	3,982	2,769	10,256	13,476	17,221	4,239	37,635
Per Capita Amounts											
General Revenue	553.58	476.18	428.86	317.93	396.53	310.78	331.86	286.13	484.17	581.01	543.65
From Property Taxes	302.77	233.76	215	161.45	204.84	148.84	152.11	139.20	179.06	196.64	207.75
General Expenditures a/	460.77	690.18	442.30	295.70	437.57	274.14	371.60	271.70	492.02	565.21	498.48
on Education	251.53	290.20	235.66	166.97	229.35	161.30	242.60	156.94	221.76	92.41	253.21
on Highways	59.84	122.96	125.99	44.57	36.41	39.07	30.37	34.96	64.14	137.30	36.28
on Hospitals	46.51	--	--	--	78.92	--	26.05	--	38.97	87.28	16.12
on Police Protection	7.62	9.62	8.54	9.41	8.21	9.53	8.54	8.32	14.74	14.97	15.07
on Sewage	2.50	17.83	1.79	2.70	--	2.16	.02	2.91	1.86	1.26	28.95
on Parks and Recreation	1.50	12.34	--	3.17	.08	3.95	3.78	3.32	3.79	6.21	5.30
on Housing and Renewal	--	--	--	--	--	--	--	--	--	--	.05

a/ Will not add since detail is not complete.

Table 2.1.4.9-9 (cont.)

Item	Central Valley Area						
	Colusa Calif.	Contra Costa California	Glenn Calif.	Sacramento California	Solano Calif.	Tehama Calif.	Yolo Calif.
General Revenue (Thous. $)	9,704	252,685	9,944	277,412	62,594	12,623	32,700
from Property Taxes	4,573	124,316	4,107	108,083	21,318	5,447	15,911
General Expenditures (Thous. $)	8,755	267,371	10,128	265,718	61,354	12,022	33,635
Per Capita Amounts							
General Revenue	766.08	491.22	526.16	464.13	377.75	435.29	340.22
from Property Taxes	360.06	241.67	217.30	180.83	128.66	187.83	183.97
General Expenditures a/	689.34	519.77	535.87	444.57	370.27	414.55	401.37
on Education	269.77	240.38	192.87	203.65	168.50	381.54	340.00
on Highways	92.72	32.03	43.54	19.10	26.66	50.61	23.33
on Hospitals	64.90	39.03	55.35	21.86	5.55	31.75	22.53
on Police Protection	17.88	17.85	17.22	14.20	15.70	13.67	15.65
on Sewage	1.39	11.54	3.73	12.12	14.51	2.64	5.32
on Parks and Recreation	.61	13.78	2.56	12.58	7.93	4.21	11.08
on Housing and Renewal	--	6.71	.06	3.07	8.29	--	1.65

a/ Will not add since detail is not complete.

Source: Census of Governments, 1966-67.

California, and an average of 50-65 percent. Highways generally rank second in the list of local expenditures.

Socio-Economic Trends

Economic projections prepared by the Bureau of Economic Analysis, U.S. Department of Commerce, are among the best available that project economic trends on a regional basis. Regions for these projections were established by selecting a major economic center (e.g., Spokane, Washington) and relating counties to these centers on the basis of economic activity patterns. Projections are based on a low national population growth rate (Bureau of the Census series E) and principally on past trends. Figure 2.1.4.9-2 is a map of BEA economic areas that relate to the proposed pipeline route.

Table 2.1.4.9-10 presents the projections of economic area trends without the proposed pipeline. These data project a slower rate of growth in the northern areas of the route and faster rates at the southern end. Mining and agriculture are expected to be the slowest growth sectors while finance, insurance and real estate and services are expected to be fast growth sectors.

2.1.4.11 Land Use

Historic Land Use Trends

Fur traders were the first white men to enter northern Idaho and eastern Washington where they established trading posts at Bonners Ferry and Spokane in the early 1800's. A British fort was established at Walla Walla, Washington, Fur traders also explored northern Nevada and eastern Oregon in the 1830's. By the 1840's immigrants were moving over the trails of the fur traders. The movement was stimulated by the California gold rush and discovery of precious metals in other sections of the West.

These frontier people were followed by cattlemen, farmers, and lumbermen who claimed ownership to the lands most suitable for their use.

Until about 1960, the principal land use and the economy was related to these basic resources. Since 1960 recreation-oriented uses have gained a significant place in the economy of northern Idaho, eastern Washington, Oregon and northern California.

The general trend appears toward increased recreational use and increased energy and mineral exploration and development. (See Figure 2.1.4.11-1.)

Current Land Use

Agricultural-Forestry

The U.S. Soil Conservation Service compiled in 1965 a land resource map of the United States which depicts resource regions and areas based on soils, climate and the resulting types of agricultural usage.

Land use patterns have changed very little since 1965. This inventory adequately describes present land use conditions along the proposed pipeline route.

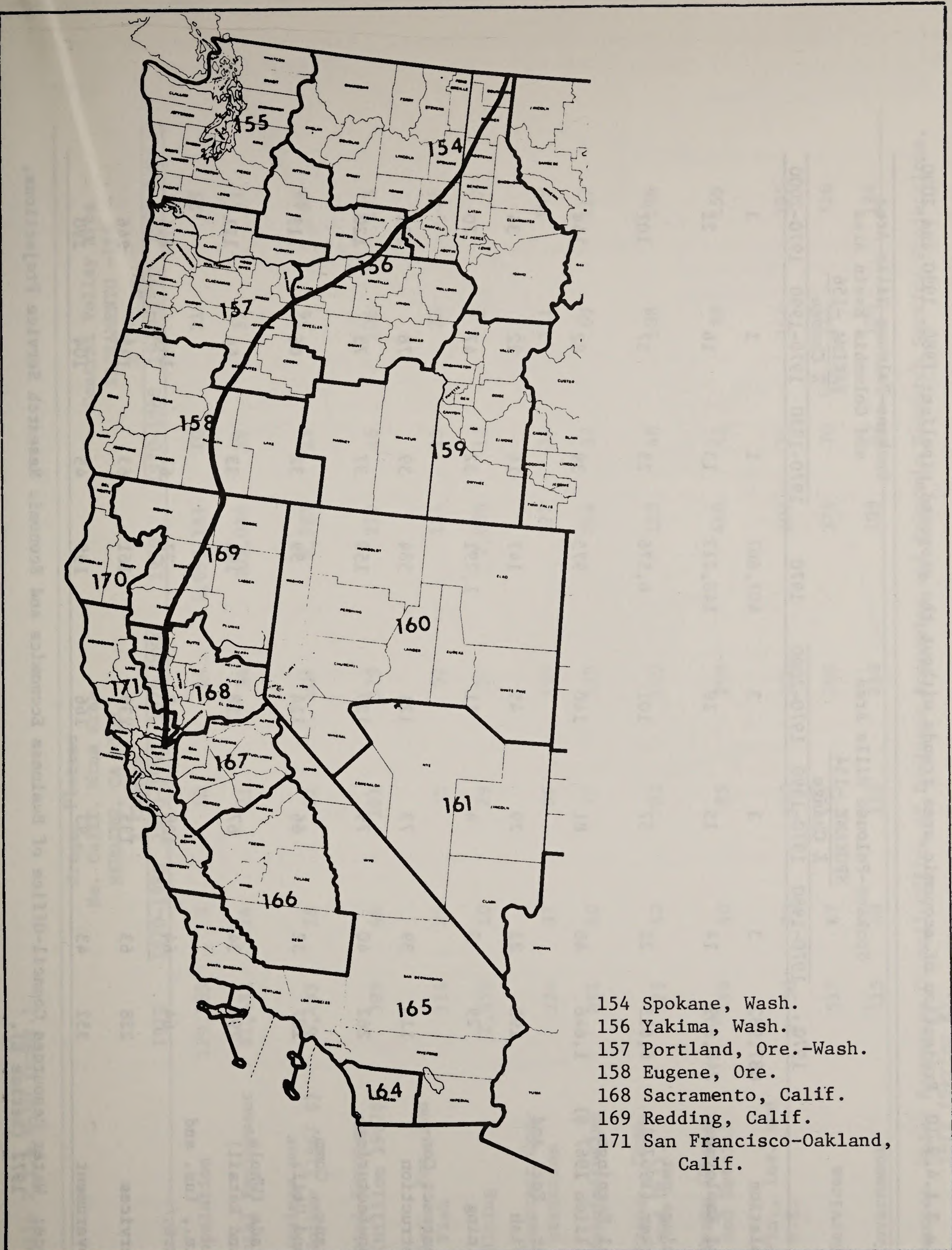


Figure 2.1.4.9-2 Bureau of Economic Analysis economic areas

Table 2.1.4.9-10 Projection of economic area trends without the proposed pipeline: 1980, 1990 and 2000.

	Spokane-Palouse Hills Area SPOKANE -154				Spokane-Palouse Hills Area and Columbia Basin Area YAKIMA -156			
		% Change				% Change		
	1970	1970-1980	1970-1990	1970-2000	1970	1970-1980	1970-1990	1970-2000
Population	687,982	3	3	3	407,607	1	1	3
Total Employment	248,909	14	15	19	148,212	13	16	21
Earnings per Worker (1967 $)	6,613	22	57	101	6,576	23	57	101
Total Earnings (Million 1967 $)	1,646	40	81	140	975	39	82	144
Agr., For. and Fish	195	21	29	45	147	16	22	34
Mining	29	5	4	11	1,291	32	47	70
Contract Construction	115	39	73	121	584	39	78	133
Manufacturing	262	40	79	129	159	37	73	120
Trans., Comm. and Util.	107	32	66	114	59	31	66	119
Trade (Whols. and Retail)	294	34	67	118	166	33	64	111
Fin., Ins. and R.E.	64	64	128	217	27	67	141	244
Services	228	63	135	239	161	63	135	246
Government	352	43	93	166	195	45	104	190

Source: Water Resources Council-Office of Business Economics and Economic Research Service Projections, 1972 (Series E).

Table 2.1.4.9-10 (cont.)

	Oregon Plateau - No. Calif. Mtns Area REDDING, CA -169				Central Valley Area SACRAMENTO -168			
		% Change				% Change		
	1970	1970-1980	1970-1990	1970-2000	1970	1970-1980	1970-1990	1970-2000
Population	179,165	3	10	14	1,093,181	10	21	29
Total Employment	61,432	14	23	34	403,034	19	32	47
Earnings per Worker (1967 $)	6,493	28	62	108	6,925	23	56	98
Total Earnings (Million 1967$)	399	46	101	179	279	46	106	193
Agr., For. and Fish	114	25	35	52	151	15	23	36
Mining	2,550	10	29	57	2,060	12	2	7
Contract Construction	224	37	86	155	177	54	111	189
Manufacturing	891	40	77	125	264	33	69	117
Trans., Comm. and Util.	373	40	82	140	183	48	108	194
Trade (Whols. and Retail)	598	40	85	149	448	41	89	159
Fin., Ins. and R.E.	9,750	75	170	306	107	74	164	295
Services	517	67	154	286	374	70	168	316
Government	115	49	115	210	109	42	105	194

Source: Water Resources Council-Office of Business Economics and Economic Research Service Projections, 1972 (Series E).

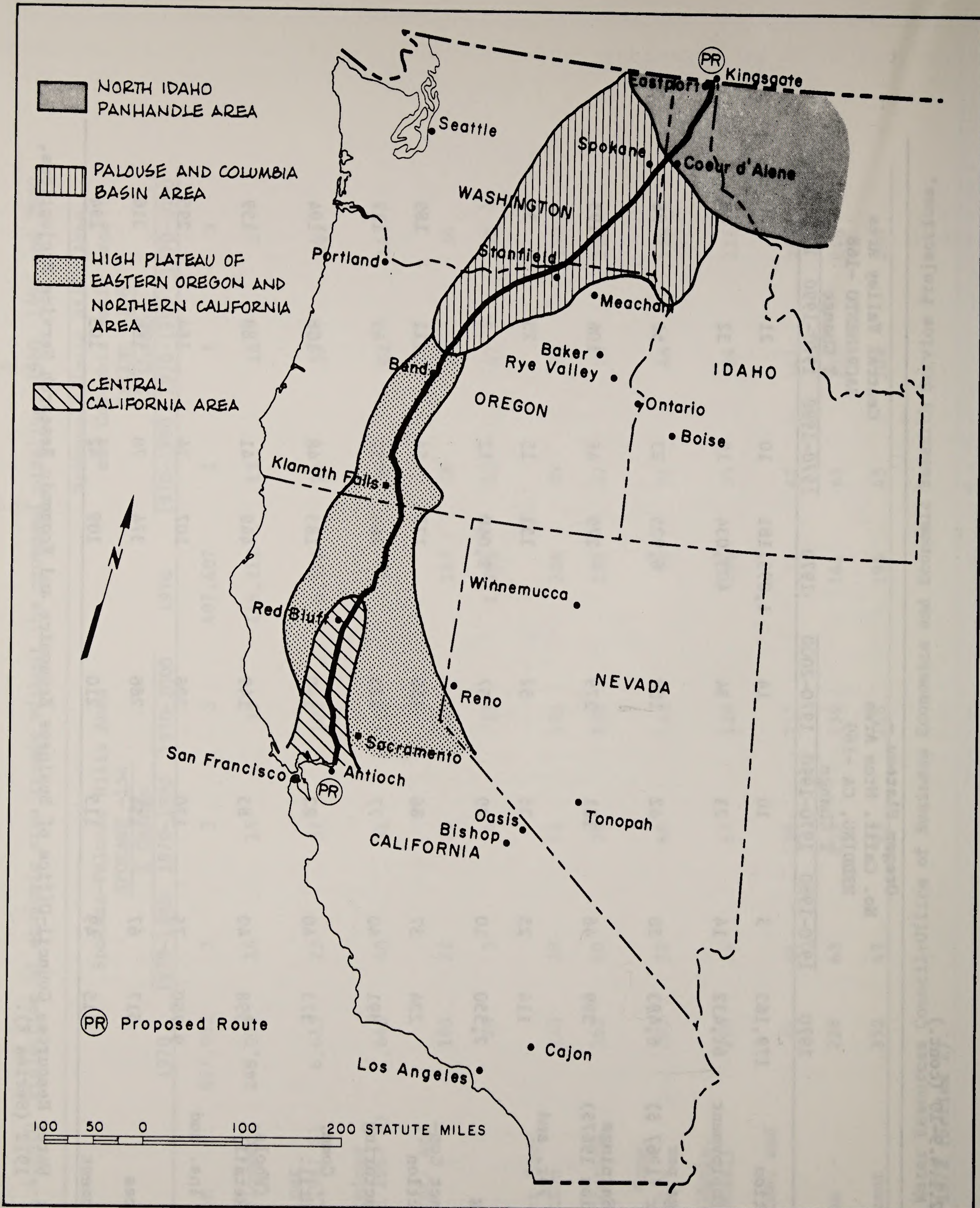


Figure 2.1.4.11-1 Regional land area descriptions

The following descriptions, which are designated as "NORTHWESTERN WHEAT AND RANGE REGION" and "WESTERN RANGE AND IRRIGATED REGION," relate to those delineations shown on Figure 2.1.4.11-2.

NORTHWESTERN WHEAT AND RANGE REGION

A few mountain ranges are included in this region of smooth to deeply dissected plains and plateaus. Wheat grown by dryfarming methods is the major crop over most of the region, but oats and peas are important also.

Cascade Mountains (Eastern Slope)--Oregon and Washington

About three-fifths of the area is owned by the Federal Government; most of the remainder is in farms, ranches, or privately owned woodlands. Much of the land, probably more than three-fourths, is in forest. Douglas-fir, larch, ponderosa pine, and lodgepole pine grow on the upper slopes where moisture is plentiful. Lumbering is important in these forests, which also serve as wildlife habitat and for recreation. Parklike woodlands at the lower elevations have an understory of grass, sagebrush, and bitterbrush and are used for grazing. About 5 percent of the area, mostly in valleys, is cropland, most of which is irrigated.

Columbia Plateau--Washington and Oregon

More than 90 percent of the area is in farms or ranches, about 7 percent is owned by the Federal Government, and the remainder is urban. Nearly one-half of the land is cropland, most of which is dryfarmed. The main crops are wheat and peas, but a little land is in hay and improved pasture. Some small areas along the major streams are irrigated and used for growing vegetables, fruits (mainly apples), and hay. Nearly all the remaining land, about two-fifths of the total area is in rangeland.

Palouse and Nez Perce Prairies--Washington, Oregon, and Idaho

About one-third of the area is owned by the Federal Government; nearly all the remainder is in farms and ranches. Much of the publicly owned land and about one-fourth of the land in ranches, consisting of the drier and more sloping uplands, is in range. About two-fifths of the area is cropland, most of which is dryfarmed with wheat and peas. Irrigated land, amounting to about 1 percent of the total area, is used to grow vegetables, seeds, and other specialty crops. Small wooded areas on steep slopes amount to about 10 percent of the area.

Upper Snake River Lava Plains and Hills--Idaho and Oregon

Nearly three-fifths of the area is owned by the Federal Government; most of the remainder is in farms or ranches. About three-fourths of the land is in grass and sagebrush used for range. The highest mountain slopes, about one-fifth of the area, are in forests of pine, spruce, and fir. Lumbering is important in these forests, which serve also as wildlife habitat and for recreation. About 5 percent of the total area, land bordering the large streams, is irrigated and used to grow potatoes and small grains and for pasture. Where rainfall is adequate, small areas of deep soils are dryfarmed.

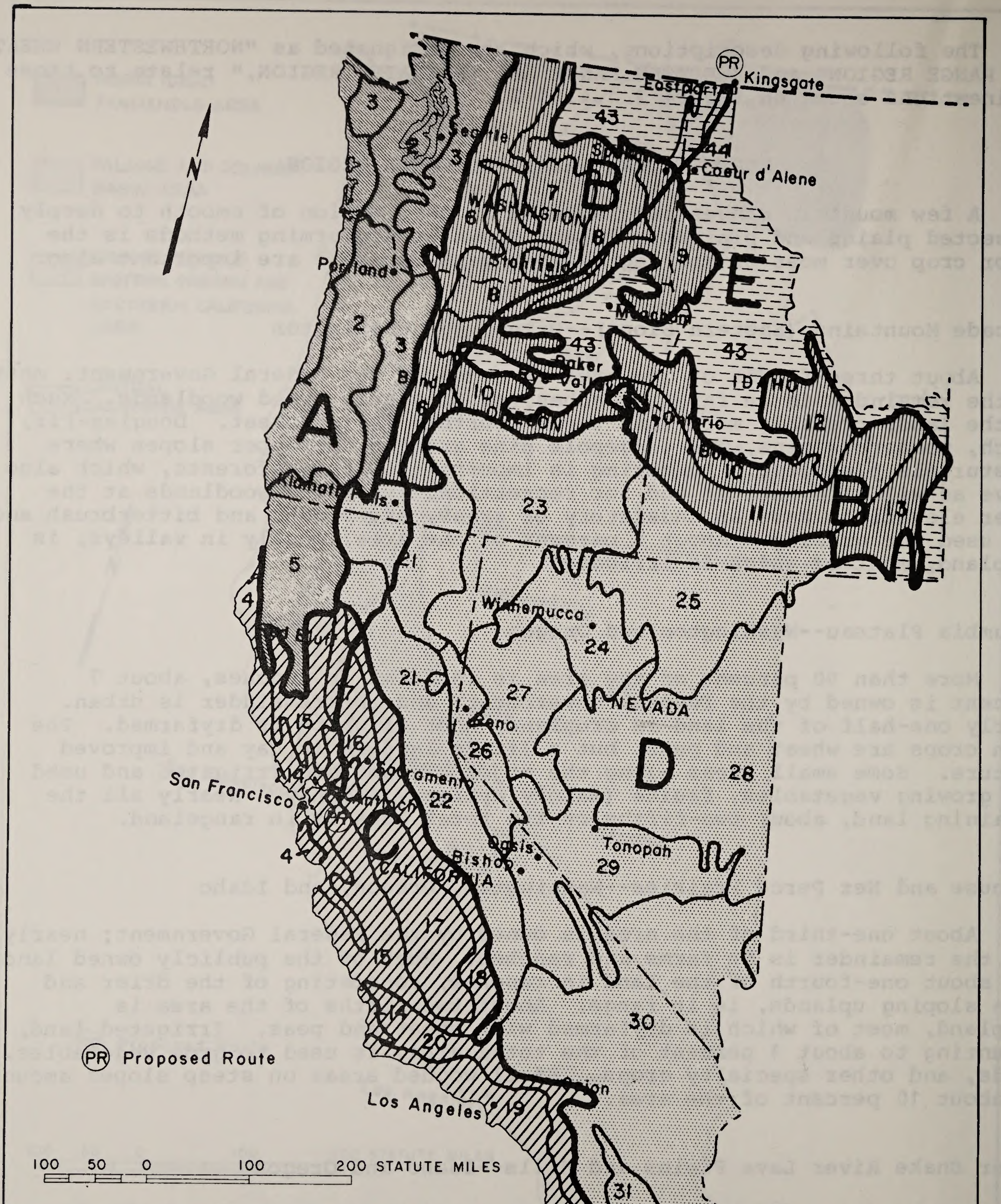


Figure 2.1.4.11-2 Land resource regions and major land resource areas

LEGEND

NORTHWESTERN FOREST, FORAGE, AND SPECIALTY CROP REGION

1 Northern Pacific Coast Range and Valleys
2 Willamette and Puget Sound Valleys
3 Olympic and Cascade Mountains (Western Slope)
4 California Coastal Redwood Belt
5 Siskiyou - Trinity Area

NORTHWESTERN WHEAT AND RANGE REGION

6 Cascade Mountains (Eastern Slope)
7 Columbia Basin
8 Columbia Plateau
9 Palouse and Nez Perce Prairies
10 Upper Snake River Lava Plains and Hills
11 Snake River Plains
12 Lost River Valleys and Mountains
13 Eastern Idaho Plateaus

CALIFORNIA SUBTROPICAL FRUIT, TRUCK, AND SPECIALTY CROP REGION

14 Central California Valleys
15 Central California Coast Range
16 California Delta
17 Sacramento and San Joaquin Valleys
18 Sierra Nevada Foothills
19 Southern California Coastal Plain
20 Southern California Mountains

WESTERN RANGE AND IRRIGATED REGION

21 Klamath and Shasta Valleys and Basins
22 Sierra Nevada Range
23 Malheur High Plateau
24 Humboldt Area
25 Owyhee High Plateau
26 Carson Basin and Mountains
27 Fallon - Lovelock Area
28 Great Salt Lake Area
29 Southern Nevada Basin and Range
30 Sonoran Basin and Range
31 Imperial Valley
32 Northern Intermountain Desertic Basins
33 Semiarid Rocky Mountains
34 Central Desertic Basins, Mountains, and Plateaus
49 (See E)
35 Colorado and Green Rivers Plateaus
36 New Mexico and Arizona Plateaus and Mesas
37 San Juan River Valley Mesas and Plateaus
38 Black, Hualpai, and Cerbat Mountains
39 Arizona and New Mexico Mountains
40 Central Arizona Basin and Range
41 Southeastern Arizona Basin and Range
42 Southern Desertic Basins, Plains, and Mountains

ROCKY MOUNTAIN RANGE AND FOREST REGION

43 Northern Rocky Mountains
44 Northern Rocky Mountain Valleys
45 Alpine Meadows and Rockland
46 Northern Rocky Mountain Foothills
47 Wasatch and Uinta Mountains
48 Southern Rocky Mountains
49 Southern Rocky Mountain Foothills
50 San Luis Valley
51 High Intermountain Valleys

ADAPTED FROM:

LAND RESOURCE REGIONS AND MAJOR LAND RESOURCE AREAS OF THE UNITED STATES. 1963. USDA-SCS-HYATTSVILLE, MD. 1969.

California Subtropical Fruit, Truck, and Specialty Crop (Region)

This region of low mountains and broad valleys has a long warm growing season and low precipitation. Many kinds of vegetables, grown mainly under irrigation, are produced throughout the region.

Sacramento and San Joaquin Valleys--California

More than 90 percent of the land is in farms and ranches. Much of the remainder is owned by the Federal Government, about 2 or 3 percent is urban and the amount of land in this use is increasing rapidly. Slightly more than half the area is cropland of which three-fourths or more is irrigated. Cotton, fruits, nuts, grapes, hay, grain, and pasture are grown on the irrigated land. The more sloping unirrigated cropland is dryfarmed to grain. About a third of the area is in native grasses, brush, and open woodland and is used mostly as rangeland.

Sierra Nevada Foothills--California

About four-fifths of the area is in farms and ranches; most of the remainder is owned by the Federal Government. Much of the area is in native and tame grasses and a sparse to thick cover of shrubs, but there are some open forests at higher elevations. Production of livestock on range is the principal enterprise of the area. Irrigated cropland in the valleys used for growing fruits, nuts, and grain makes up between 5 and 10 percent of the area.

WESTERN RANGE AND IRRIGATION REGION

This is a semidesert to desert region of plateaus, plains, basins, and many isolated mountain ranges.

Much of the land in this region is used for range, but irrigation agriculture is practiced where water is available and soils are favorable.

Klamath and Shasta Valleys and Basins--California and Oregon

About one-half of the area is owned by the Federal Government; the remainder is in farms and ranches. Between 5 and 10 percent of the land is irrigated and used to grow potatoes, grain, seed crops, and hay for pasture. An additional 1 or 2 percent is dryfarmed to grain. Most of the remaining land, both privately and publicly owned, is in grass or open woodland used for grazing. Forests of ponderosa pine, Douglas-fir, and fir on the upper mountain slopes produce some lumber.

Sierra Nevada Range--California

More than one-half of the land is owned by the Federal Government; Yosemite and Sequoia National Parks are in this area. The remainder is in privately owned forests, farms, and ranches. About 90 percent of the land is in forests of ponderosa pine, sugar pine, lodgepole pine, Douglas-fir, white fir, and Jeffrey pine. The forests are used mostly for outdoor recreation and as wildlife habitat, but lumbering is an important enterprise where the forests are privately owned. Open woodland and grassland, mostly above the timberline, provide summer grazing. Some of the valleys,

amounting to 1 or 2 percent of the total area, are used for growing hay and grain for livestock.

Rocky Mountain Range and Forest (Region)

Rugged mountains are the dominant feature of this region, but there are some broad valleys and remnants of high plateaus.

Grazing is the leading land use in both valleys and mountains, but lumbering is important in some of the forested mountain areas. Outdoor recreation is an important land use throughout the region.

Northern Rocky Mountains--Idaho, Washington, and Oregon

About four-fifths of the area is owned by the Federal Government. Yellowstone and Glacier National Parks and several other parks, forests, and monuments are in the area. Heavy forests of western white pine, ponderosa pine, lodgepole pine, larch, hemlock, Douglas-fir, and spruce cover much of the land at the upper and intermediate elevations. On lower slopes, especially in the south, forests are more open and have an undergrowth of shrubs and grasses. All the forested areas are used as wildlife habitat and for recreation; they produce timber as well. Mining is important in northern Idaho and western Montana. Meadows on the upper mountain slopes and mountain crests above timberline are used to some extent for summer grazing. Less than 2 percent of the area is cropped. Forage and grain grown under irrigation in some of the valleys provide feed for dairy cattle and other livestock. In Washington and Oregon, valleys that have enough rainfall are dryfarmed to wheat, peas, and a few other crops.

Northern Rocky Mountain Valleys--Idaho

Nearly all the area is in farms and ranches. As much as one-third of the land in some valleys is irrigated. Potatoes, sugar beets, and peas are important cash crops, but hay, grain, and pasture for livestock feed occupy a much larger acreage. Some areas that have enough rainfall are dryfarmed to wheat and peas. Between one-third and one-half of the area is in range of native grasses and shrubs. Beef cattle and sheep are the principal livestock, but dairying is important near the larger towns. Much of the area in northern Idaho is forested, and elsewhere many steep and stony soils are in woodland. These forests yield some lumber and are also used for grazing.

Irrigated Lands

Irrigated lands crossed by the proposed route are located in the Spokane area, Columbia basin area of Oregon and Washington and in the Redmond, Bend, Klamath Falls areas in Oregon, Tule Lake, and the Central California Valley from Red Bluff to the San Joaquin River areas in California.

The Bureau of Reclamation identified the following projects that would be affected by the proposed pipeline:

Proposed Projects

Marcus Whiteman Division

Walla Walla Project, Washington--The proposed pipeline will traverse the project in the vicinity of the proposed Wallula Relift Pumping Plant site and the proposed West Vansycle Relift Pumping Plant and the Low Wallula-Gardena Canal site.

Umatilla Project, Oregon--The proposed pipeline will cross the proposed Cold Springs Canal carrying Columbia River water for storage in Cold Springs Reservoir.

Columbia South Side Project, Oregon--The proposed pipeline would cross the southern portion of the Sand Hollow area. (See Figure 2.1.4.11-3.)

Projects Under Construction

Rathdrum Prairie, East Greenacres Unit, Idaho--The proposed pipeline will enter the project area in the NE 1/4 section 11, T. 51 N,R.5 W., B M, thence diagonally across sections 11, 15, 16, 21, 20, and 29, crossing 7 irrigation pipelines.

Existing Projects

Spokane Valley Project, Washington--The proposed pipeline will enter the project area in T. 25 N., R. 45 E., W M, section 16, NE 1/4 to SW 1/4, section 21, NW 1/4 to NW 1/4, section 20, NE 1/4 to SE 1/4, crossing 4 pipelines.

Umatilla Project, Oregon--The proposed pipeline will cross the existing project system, including Furnish Canal, Cold Springs Feeder Canal, and Westland Canal. It will affect existing productive agricultural lands.

Also the proposed pipeline will cross existing canal distribution systems in Oregon as follows:

Crook County Improvement District No. 1, Oregon (Lone Pine)

Central Oregon Irrigation District, Oregon

Arnold Irrigation District, Oregon

Deschutes Irrigation District, North Unit, Oregon

The Bureau of Reclamation is in the process of identifying potential dam and storage sites along the Sprague and Williamson Rivers for their Butte Valley-Upper Klamath River Basin Study. Based on appraisal data, the following sites were previously considered: Braymill site, Sprague River, T.34S., R.7E., S.25; S'Ocholis site, Sprague River T.25S., R.10E., S.4; Sprague River site, Sprague River T.36S., R.11 1/2 E., S.11; Yamsay site,

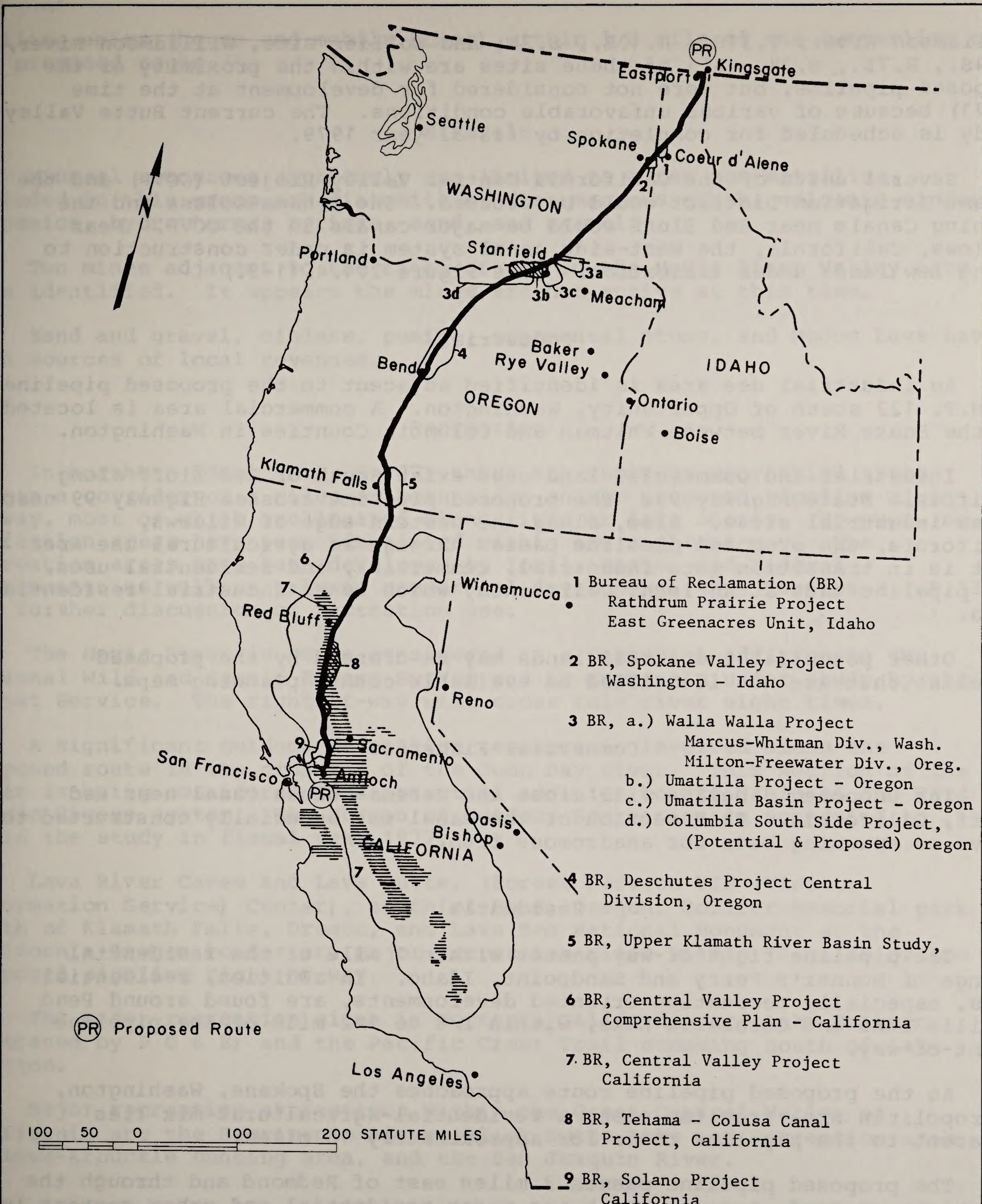


Figure 2.1.4.11-3 Bureau of Reclamation projects map

Williamson River, T.31S., R.10E., S.24; and Collier site, Williamson River, T.34S., R.7E., S.34. All of these sites are within the proximity of the proposed pipeline, but were not considered for development at the time (1971) because of various unfavorable conditions. The current Butte Valley Study is scheduled for completion by fiscal year 1979.

Several units of the California Central Valley Project (CCVP) and the Solano Irrigation District would be crossed. The Tehama-Colusa and the Corning Canals near Red Bluff would be major canals in the CCVP. Near Willows, California, the West-side canal system is under construction to bring new lands under irrigation. (See Figure 2.1.4.11-3.)

Industrial

An industrial use area is identified adjacent to the proposed pipeline at M.P. 122 south of Opportunity, Washington. A commercial area is located at the Snake River between Whitman and Columbia Counties in Washington.

Industrial and commercial land uses exist South of Red Bluff along California State Highway 99. The proposed pipeline crosses Highway 99 near these industrial sites. Also, along the western edge of Willows, California, the proposed pipeline passes through an agricultural use area that is in transition into industrial, commercial, and residential uses. The pipeline ends at Antioch, California, which is an industrial-residential area.

Other potential industrial lands may be crossed by the proposed pipeline that are not identified on available county planning maps.

Commercial Fisheries

The proposed pipeline will cross the Tehama-Colusa Canal near Red Bluff, California. This section of the canal was especially constructed to serve as spawning beds for anadromous fish.

Residential

The pipeline right-of-way passes within 1 mile of the residential fringe of Bonner's Ferry and Sandpoint, Idaho. In addition, residential uses, especially recreation-oriented developments, are found around Pend Oreille Lake and Cocolalla Lake, within 1/8 to 1/2 mile of the pipeline right-of-way.

As the proposed pipeline route approaches the Spokane, Washington, metropolitan area from the east, a residential-agricultural mix lies adjacent to the pipeline route for approximately 15 miles.

The proposed pipeline passes 3 miles east of Redmond and through the outskirts of Bend, Oregon, which are major residential and urban centers in central Oregon.

At Winters, California, the right-of-way is adjacent to a residential subdivision.

Residential areas exist near the proposed pipeline in northern Idaho; Spokane, Washington; Hermiston, Redmond, Bend, and Klamath Falls, Oregon; and at Burney, Red Bluff, Willows, and Winters, California. There are 586

dwelling units (house and mobile homes) within 1/8 mile of the centerline of the proposed route.

Minerals

Mineral resources apparently are limited to a few non-metallics. Included in this group are diatomite or diatomaceous earth, volcanic cinders or pumice, hydrothermal springs, sand, and gravel.

Two mines adjacent to the right-of-way in the Moyie River Valley have been identified. It appears the mines are not active at this time.

Sand and gravel, cinders, pumice, ornamental stone, and Modoc Lava have been sources of local revenues.

Recreation

In northern Idaho (M.P. 0-107) there are numerous recreation sites within a corridor of 5 miles on both sides on the proposed pipeline right-of-way, most of which are located along river or lake shores. However, no recreation areas have been identified within the right-of-way. The recreation areas have been developed by local, State, and Federal government, as well as private commercial developers. See Section 2.1.4.13 for further discussion of recreation use.

The Moyie River is being considered as a potential addition to the National Wild and Scenic Rivers System and is presently under study by the Forest Service. The right-of-way will cross this river eight times.

A significant outdoor recreation resource is involved along the proposed route in the crossing of the John Day river. This section of the river is being considered as a potential addition to the National and Wild Scenic Rivers system. The Bureau of Outdoor Recreation is scheduled to begin the study in fiscal year 1977.

Lava River Caves and Lava Butte, (Forest Service VIS (Visitor Information Service) Center), south of Bend, Oregon, Collier Memorial park north of Klamath Falls, Oregon, and Lava Bed National Monument at the California-Oregon border are major recreation sites within 10 miles of the proposed pipeline right-of-way.

The major recreation sites in Northern California are Lake Britton (operated by P G & E) and the Pacific Crest Trail crossing south of Lake Britton.

Major recreation attractions within the Great Central Valley of California are the Sacramento River, Black Butte Lake and Recreation area, Willows-Arbuckle hunting area, and the San Joaquin River.

Federal and State Reserves

The Federal Government has the management responsibility over large tracts of land in national forests, wildlife refuges, parks, and reservoir sites throughout the West. The Agricultural Forestry narrative description in this section describes the amount of land owned by the Federal Government in the various land resource areas.

Tabulated below are the public lands crossed by the Applicant's existing and proposed parallel pipeline and the Agency administering such lands:

Kanisksu National Forest; administered by the Department of Agriculture

Natural Resource lands in Idaho, Oregon, and California; administered by the Department of Interior, Bureau of Land Management

Ochoco National Forest; Central Oregon National Grasslands; administered by the Department of Agriculture

Deschutes National Forest; administered by the Department of Agriculture

Winema National Forest; administered by the Department of Agriculture

Modoc National Forest; administered by the Department of Agriculture

Shasta Trinity National Forest; administered by the Department of Agriculture

Lassen National Forest; administered by the Department of Agriculture

The reader is referred to Sections 2.1.4.7 and .13 for additional information on Federal and State land ownership.

Transportation Facilities

Forty-nine crossings of five railroads will be necessary. At least 5 interstate highways, 15 Federal highways, 30 State highways, and 69 light duty county, forest and local roads would be crossed by the pipeline. In addition, numerous powerline and petroleum product transmission lines would be intersected. Eighteen major and several smaller irrigation canals and water distribution systems will be crossed. (See Table 2.1.4.11-1.)

Highways and Roads (See Figure 2.1.4.11-4)

<u>North</u> <u>Idaho</u> <u>Panhandle</u> <u>Area</u>--Major transportation corridors in the area include U.S. Highway 95 and Idaho State Highways 2, 41, 53 and 54.

Within this segment of the proposed pipeline there will be nine paved road or highway crossings.

<u>Palouse</u> <u>and</u> <u>Columbia</u> <u>Basin</u> <u>Area</u>--Major highways in the area include Washington State Highway 290, Interstate Highway 90, Washington State Highway 23 (near St. John), 26 (near LaCrosse), 261 (near Starbuck), 124 (near Eureka), U.S. Highway 12 (near Wallula), U.S. Highway 395 (south of Juniper Canyon, Oregon), Washington State Highway 195 (near Spangle), Oregon Highway 207, Oregon Highway 74 (near Ione), and Oregon Highways 206 and 19 (near Condon). U.S. Highway 97 crosses the pipeline route twice near Shaniko, Oregon, and generally parallels the right-of-way from that point south. The pipeline route also crosses Interstate 80N south of Hermiston, Oregon.

This segment of the pipeline involves 18 paved road or highway crossings.

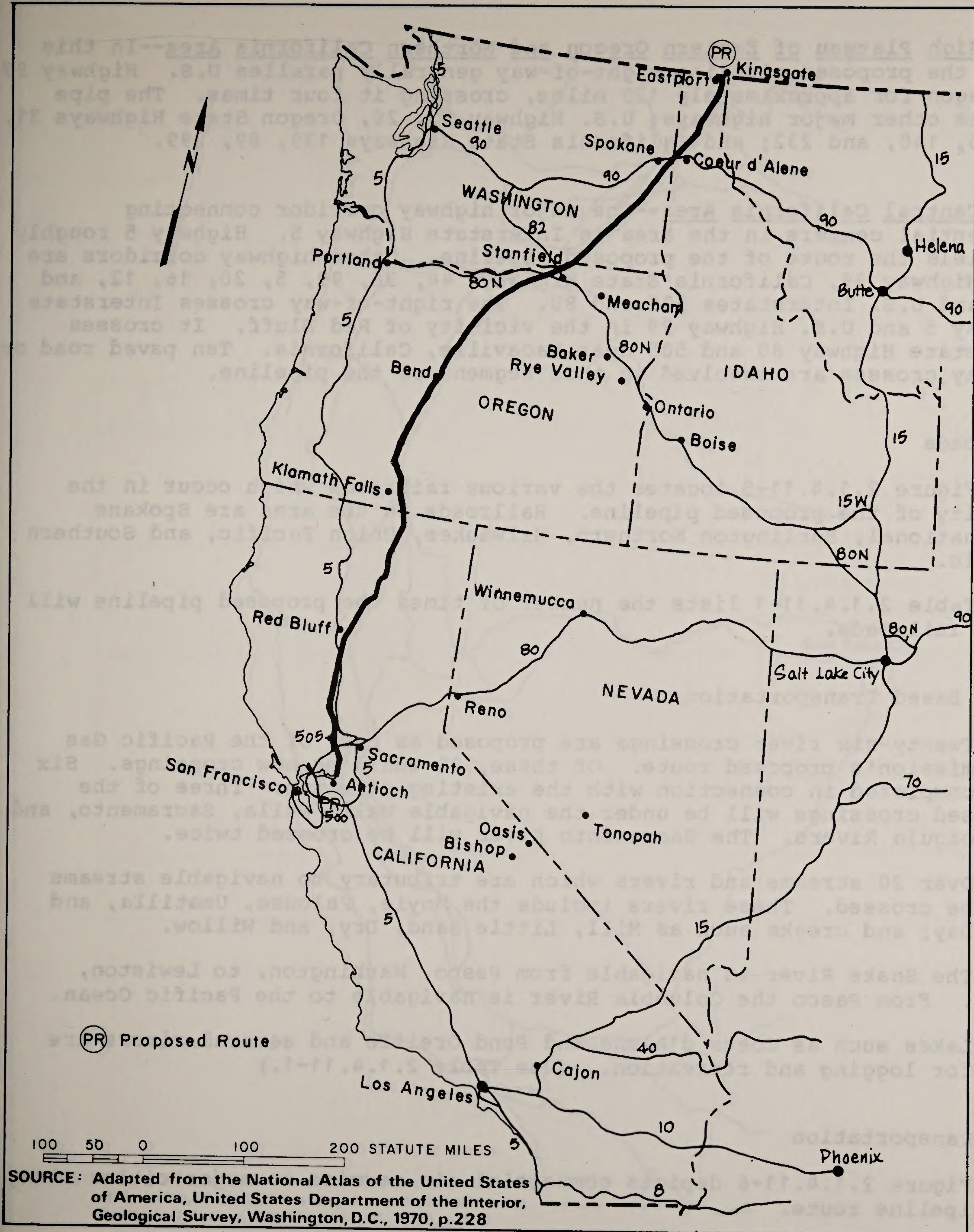


Figure 2.1.4.11-4 Interstate highways in proximity to the proposed route

High Plateau of Eastern Oregon and Northern California Area--In this area, the proposed pipeline right-of-way generally paralles U.S. Highway 97 in Oregon for approximately 120 miles, crossing it four times. The pipe crosses other major highways: U.S. Highway 20, 26, Oregon State Highways 31, 58, 66, 140, and 232; and California State Highways 139, 89, 299.

Central California Area--The major highway corridor connecting residential centers in the area is Interstate Highway 5. Highway 5 roughly parallels the route of the proposed pipeline. Other highway corridors are U.S. Highway 99, California State Highways 44, 36, 99, 5, 20, 16, 12, and 160, and U.S. Interstates 505 and 80. The right-of-way crosses Interstate Highway 5 and U.S. Highway 99 in the vicinity of Red Bluff. It crosses Interstate Highway 80 and 505 near Vacaville, California. Ten paved road or highway crosses are involved in this segment of the pipeline.

Railroads

Figure 2.1.4.11-5 locates the various railroads which occur in the vicinity of the proposed pipeline. Railroads in the area are Spokane International, Burlington Northern, Milwaukee, Union Pacific, and Southern Pacific.

Table 2.1.4.11-1 lists the number of times the proposed pipeline will cross railroads.

Water Based Transportation

Twenty-six river crossings are proposed as part of the Pacific Gas Transmission's proposed route. Of these, 20 would be new crossings. Six were completed in connection with the existing pipeline. Three of the proposed crossings will be under the navigable Walla Walla, Sacramento, and San Joaquin Rivers. The Sacramento River will be crossed twice.

Over 20 streams and rivers which are tributary to navigable streams will be crossed. These rivers include the Moyie, Palouse, Umatilla, and John Day; and creeks such as Mill, Little Sand, Dry, and Willow.

The Snake River is navigable from Pasco, Washington, to Lewiston, Idaho. From Pasco the Columbia River is navigable to the Pacific Ocean.

Lakes such as Coeur d'Alene and Pend Oreille and several rivers are used for logging and recreation. (See Table 2.1.4.11-1.)

Air Transportation

Figure 2.1.4.11-6 depicts commercial air service to major cities along the pipeline route.

No airports or heliports are within the proposed pipeline right-of-way.

Transmission Facilities

Transmission facilities for natural gas and petroleum rights-of-way are located along the proposed pipeline route. See Figure 2.1.4.11-7 and Figure 2.1.4.11-8 for locations.

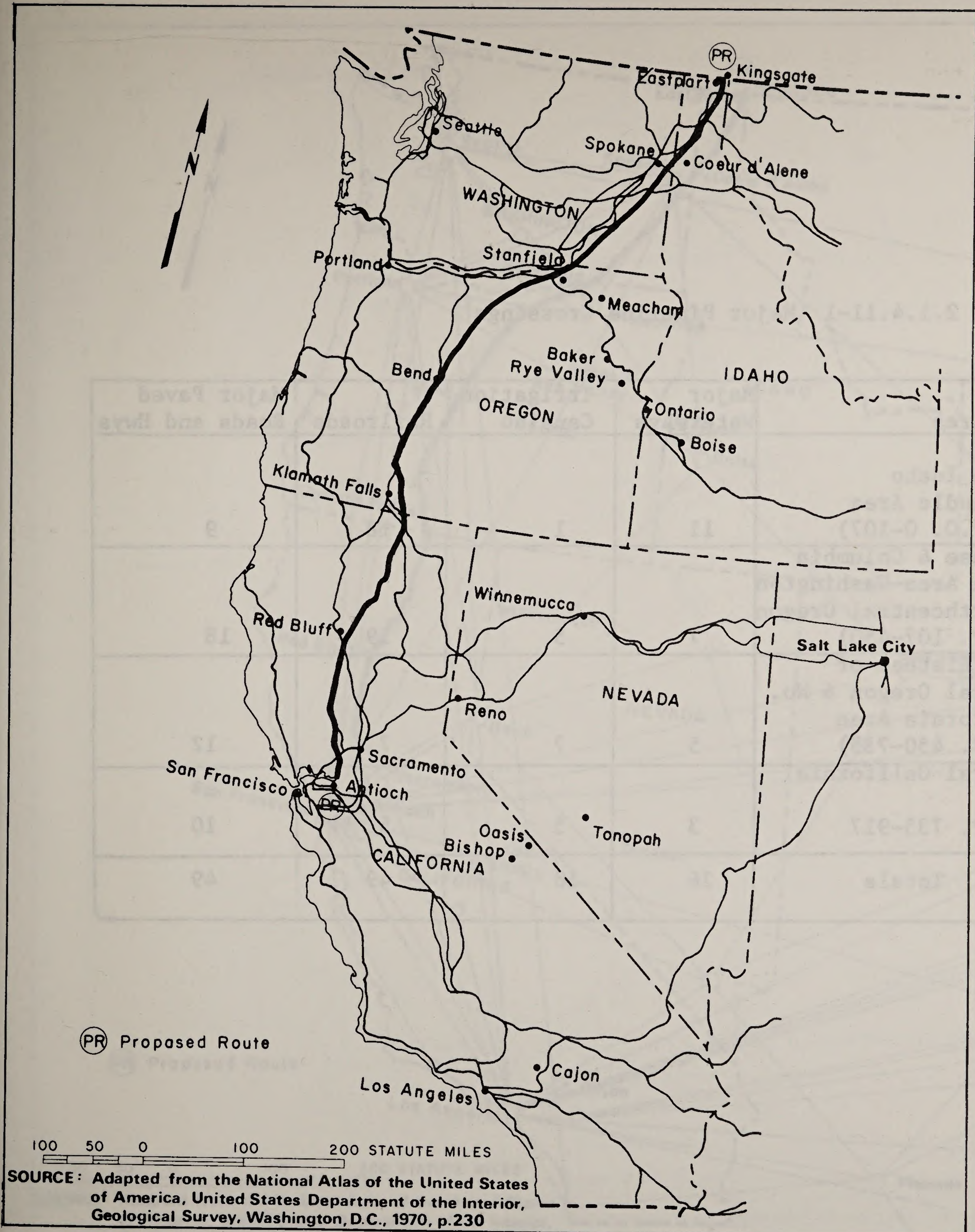
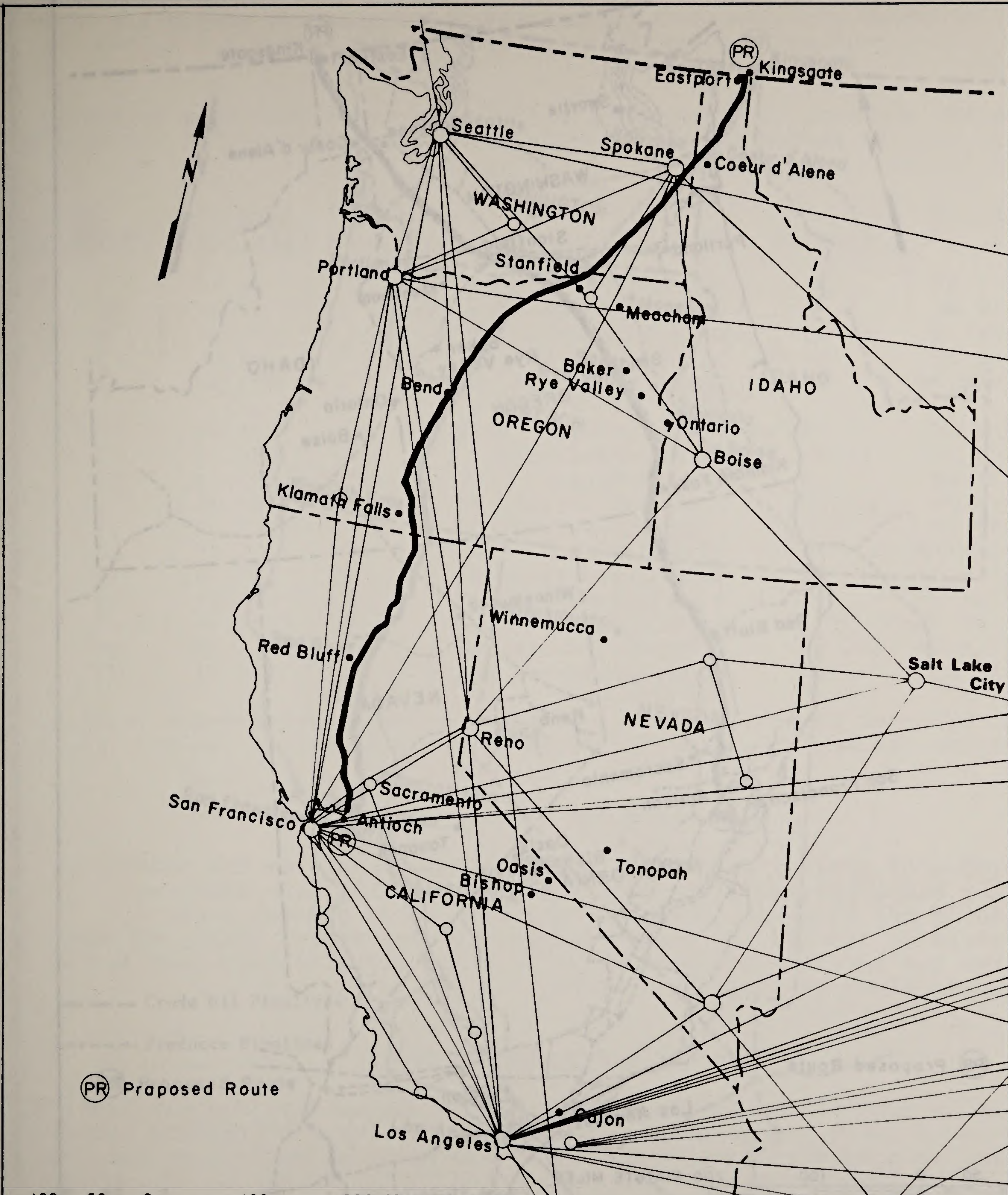


Figure 2.1.4.11-5 Primary railroads in proximity to the proposed route

Table 2.1.4.11-1 Major Pipeline Crossings

Area	Major Waterways	Irrigation Canals	Railroads	Major Paved Roads and Hwys
North Idaho Panhandle Area (M.P.O. 0-107)	11	1	18	9
Palouse & Columbia Basin Area-Washington & Northcentral Oregon (M.P. 107-450)	7	5	19	18
High Plateau of Central Oregon & No. California Area (M.P. 450-735)	5	7	7	12
Central California Area (M.P. 735-917	3	5	5	10
Totals	26	18	49	49



SOURCE: Adapted from the National Atlas of the United States of America, United States Department of the Interior, Geological Survey, Washington, D.C., 1970, p. 232

Figure 2.1.4.11-6 Commercial air service in proximity to the proposed route

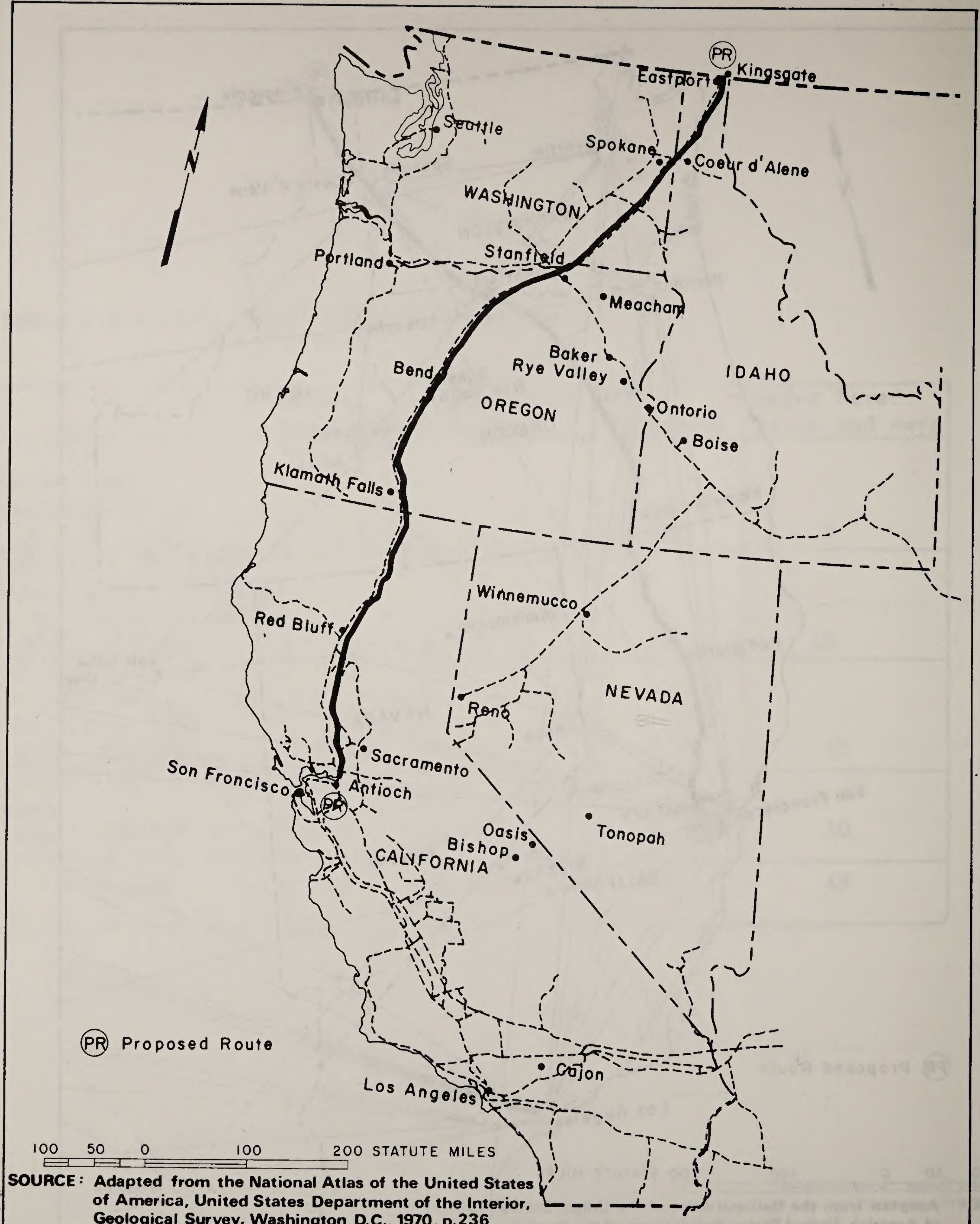


Figure 2.1.4.11-7 Natural gas pipelines in proximity to the proposed route

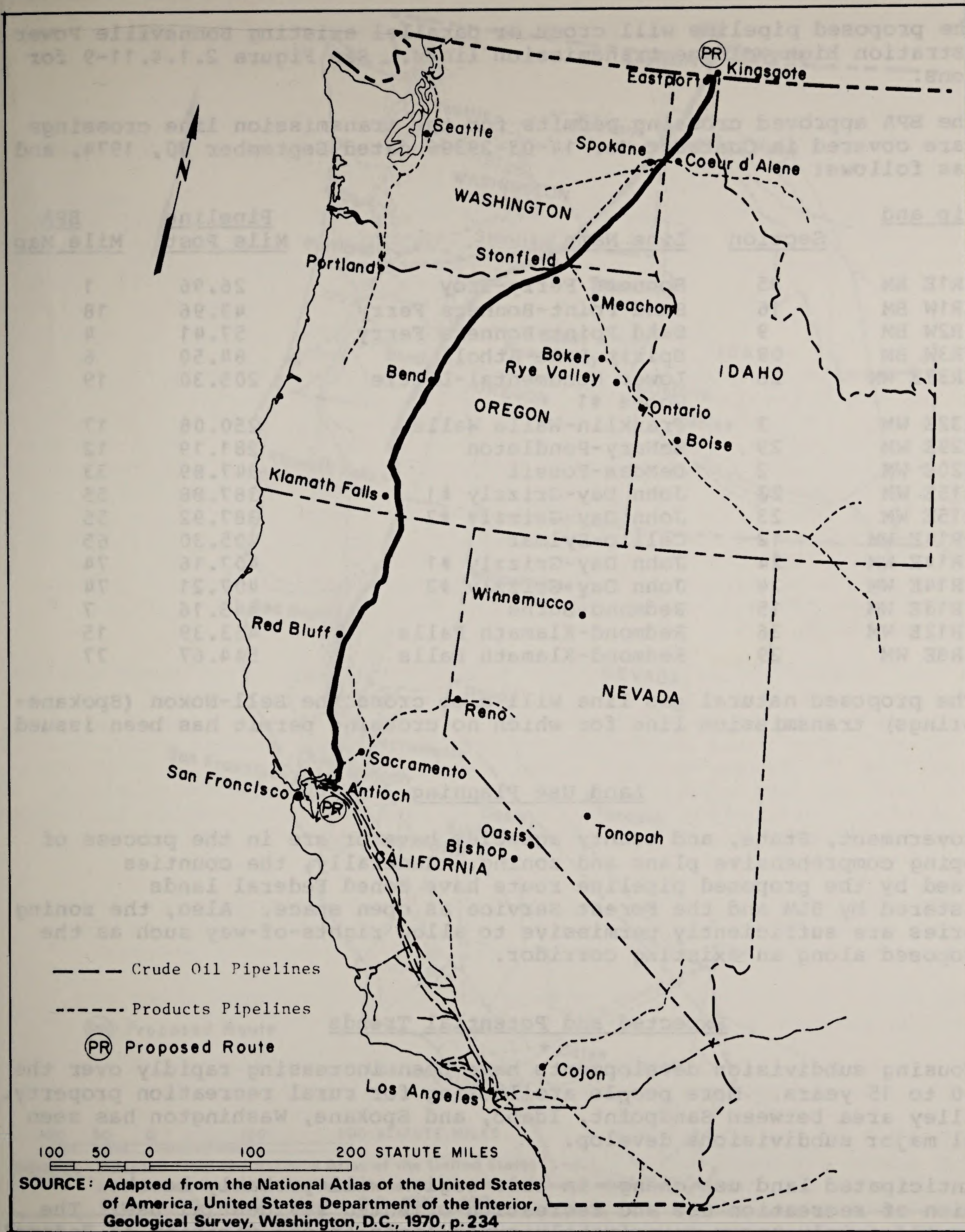


Figure 2.1.4.11-8 Crude oil and products pipelines in proximity to the proposed route

The proposed pipeline will cross or parallel existing Bonneville Power Administration high voltage transmission lines. See Figure 2.1.4.11-9 for locations.

The BPA approved crossing permits for the transmission line crossings which are covered in Contract No. 14-03-29396 dated September 30, 1974, and shown as follows:

Township and Range	Section	Line Name	Pipeline Mile Post	BPA Mile Map
T62N, R1E BM	35	Bonners Ferry-Troy	26.96	1
T59N, R1W BM	16	Sand Point-Bonners Ferry	43.96	18
T57N, R2W BM	9	Sand Point-Bonners Ferry	57.41	4
T53N, R3W BM	9	Spirit Lake-Athol	84.50	6
T13N, R37E WM	28	Lower Monumental-Little Goose #1	205.30	19
T7N, R32E WM	3	Franklin-Walla Walla	250.08	17
T4N, R29E WM	29	McNary-Pendleton	281.19	12
T4S, R20E WM	2	DeMoss-Fossil	347.89	33
T7S, R15E WM	23	John Day-Grizzly #1	387.88	55
T7S, R15E WM	23	John Day-Grizzly #2	387.92	55
T10S, R14E WM	12	Celilo-Sylmar	405.30	65
T10S, R14E WM	24	John Day-Grizzly #1	407.16	74
T10S, R14E WM	24	John Day-Grizzly #2	407.21	74
T16S, R13E WM	15	Redmond-Burns	443.16	7
T17S, R12E WM	36	Redmond-Klamath Falls	453.39	15
T26S, R8E WM	29	Redmond-Klamath Falls	514.67	77

The proposed natural gas line will also cross the Bell-Noxon (Spokane-Hot Springs) transmission line for which no crossing permit has been issued.

Land Use Planning

Government, State, and county agencies have or are in the process of developing comprehensive plans and zoning. Generally, the counties traversed by the proposed pipeline route have zoned Federal lands administered by BLM and the Forest Service as open space. Also, the zoning categories are sufficiently permissive to allow rights-of-way such as the one proposed along an existing corridor.

Expected and Potential Trends

Housing subdivision developments have been increasing rapidly over the last 10 to 15 years. More people are looking for rural recreation property. The valley area between Sandpoint, Idaho, and Spokane, Washington has seen several major subdivisions develop.

Anticipated land use change in this region will probably be the expansion of recreation use and recreation-oriented residential use. The change will mainly occur on privately owned lands in the vicinity of Federal lands, particularly where natural features such as streams and lakes exist and where agriculture is marginal.

Potential land use changes in the region will probably be the expansion of residential use near existing centers. Subdivision development is active near Redmond, Bend, LaPine, Oregon and northeast of Burney, California.

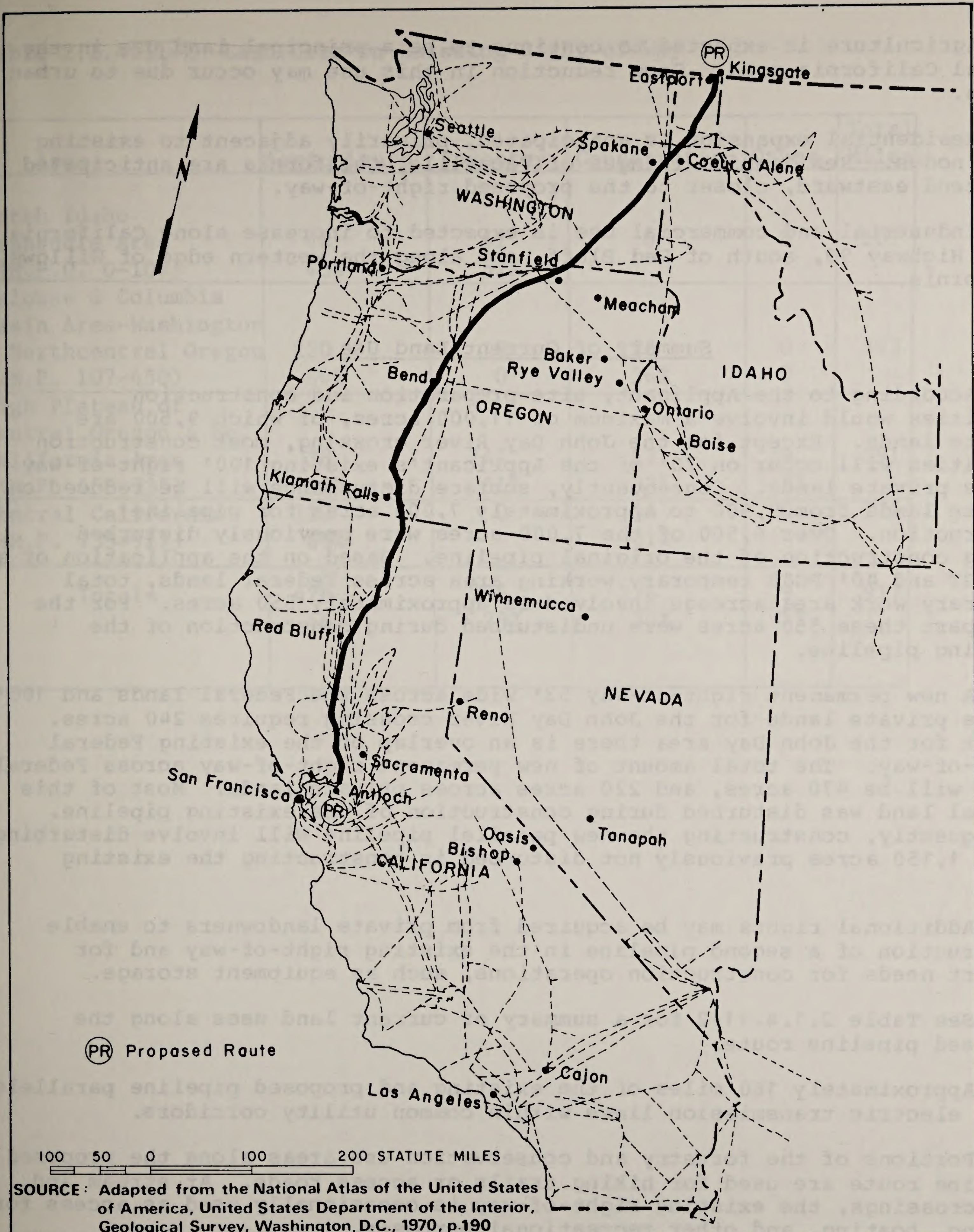


Figure 2.1.4.11-9 Major power transmission lines in proximity to the proposed route

Agriculture is expected to continue to be a principal land use in the Central California area. Some reduction in this use may occur due to urban growth.

Residential expansion is anticipated, primarily adjacent to existing urban nodes. Residential fringes of Vacaville, California are anticipated to extend eastward, closer to the proposed right-of-way.

Industrial and commercial use is expected to increase along California State Highway 99, south of Red Bluff, and along the western edge of Willows, California.

Summary of Current Land Use

According to the Applicant, site preparation and construction activities would involve a maximum of 11,000 acres, of which 9,500 are private lands. Except for the John Day River crossing, most construction activities will occur on 70' of the Applicant's existing 100' right-of-way across private lands. Consequently, surface disturbance will be reduced on private lands from 9,500 to approximately 7,000 acres for pipeline construction. Over 6,500 of the 7,000 acres were previously disturbed during construction of the original pipeline. Based on the application of a 25' PGT and 40' PG&E temporary working area across Federal lands, total temporary work area acreage involved is approximately 550 acres. For the most part these 550 acres were undisturbed during construction of the existing pipeline.

A new permanent right-of-way 53' wide across the Federal lands and 100' across private lands for the John Day River crossing requires 240 acres. Except for the John Day area there is an overlap of the existing Federal right-of-way. The total amount of new permanent right-of-way across Federal lands will be 470 acres, and 220 acres across private lands. Most of this Federal land was disturbed during construction of the existing pipeline. Consequently, constructing the new parallel pipeline will involve disturbing about 1,150 acres previously not disturbed in constructing the existing line.

Additional rights may be acquired from private landowners to enable construction of a second pipeline in the existing right-of-way and for support needs for construction operations, such as equipment storage.

See Table 2.1.4.11-2 for a summary of current land uses along the proposed pipeline route.

Approximately 160 miles of the existing and proposed pipeline parallels major electric transmission lines within common utility corridors.

Portions of the forestry and conservation use areas along the proposed pipeline route are used for hiking trails or access roads. At stream and lake crossings, the existing right-of-way is occasionally used as access for fishing, boating, and other recreational purposes.

Minor land uses adjacent to the right-of-way include residential, industrial, and recreational uses. There are 586 dwelling units and about 40 industrial establishments including pipeline compressor stations within 1/8 mile of the centerline of the proposed pipeline right-of-way. Public outdoor recreation sites, campgrounds, and State parks are located within 1 mile of the proposed route. See section 2.1.4.13 for locations and more discussion of recreation resources and facilities.

Table 2.1.4.11-2 Land Uses On Existing Right-of-Way

Area	Agriculture	Forestry	Conservation	Other	Total Miles
North Idaho Panhandle Area (M.P.O. 0-107)	46 43%	61 57%	0	0	107
Palouse & Columbia Basin Area-Washington & Northcentral Oregon (M.P. 107-450)	220 64%	0 0	123 36%	0 0	343
High Plateau of Central Oregon & No. California Area (M.P. 450-735)	38 13%	147 51%	97 33%	9 3%	291
Central California (M.P. 735-917)	122 69%	0	54 31%	0	176
Totals	426 46%	208 23%	274 30%	9 1%	917

2.1.4.12 Archeological, Historical and Other Unique Values

Archeological Background

The pipeline right-of-way passes through two areas of significant prehistorical and historical aboriginal cultural development. The areas are: (1) the Interior Plateau culture area and (2) the Interior Valley sub-area. Each area is described in terms of the existing archeological data for that region based on the generally accepted synthesis of that data.

Interior Plateau Culture Area

This culture area extends over sections of British Columbia, Washington, Oregon, Idaho and Montana, through which the proposed San Francisco pipeline will be placed. While the Interior Plateau Culture Area lacks the distinctive elements of such cohesive culture areas as Northwest Coast Culture Area, which it borders, it nevertheless displays a consistent pattern of cultural development through time as evidenced in archeological record which would allow for the Interior Plateau Culture Area designation as "the hearth of a separate major cultural tradition." This area then must be approached not in comparative terms with more elaborate culture areas but in terms of its prehistoric and historic uniqueness. Within this area there is seen an adaptive sequence which reflects external influences from both Great Basin and eastern boreal adaptations, as well as an early riverine orientation which served as the basis for the development of part of the Northwest Riverine and Northwest Coast traditions.

The archeological record for the Plateau area can be generally broken down into the following periods: Early Period (Old Cordilleran), 8000-5500 B.C.; Middle Period, 5500 B.C.-A.D. 500; Late Period, A.D. 500-1800. These dates are based on a chronology discussed by Willey (1966), and Butler (1958, 1959) and are subject to some interpretation by other authors.

Some of the earliest archeological evidence in the Plateau area comes from sites in the Dalles-Deschutes region of the Columbia River valley. From these sites comes evidence of an early riverine subsistence orientation which relied on river hunting and salmon fishing. Although evidence of a more nomadic subsistence precedes the riverine orientation, the important factor here is the early orientation to river resources.

Willey (p. 398) states that these early remains, representative of what is termed the Old Cordilleran culture, served as the basis for later cultural development on the Northwest Coast. Old Cordilleran artifacts and habitation debris from the Five Mile Rapids site have been dated at 7,800 B.C., with this early culture phase established possibly as early as 9,000 B.C. The early tool assemblage consists of leaf-shaped bi-points, bolas and burins. The later archeological remains consist of leaf-shaped projectile points and blades, flint burins, harpoon prongs, atlatl spurs or hooks, beveled antler implements possibly associated with hide dressing, and grooved stones perhaps used as bolas stones or net-weights.

The Middle Period archeological remains indicate a possible climatic change and additional refinements in both economic and social orientation. Initially, though, evidence from the Five Mile Rapids site indicates that early in the Middle period there was a decline in the use of the area and a decline in the quality of artifacts. This interpretation is based on the diminished archeological remains for the period between 5000-4100 B.C. This period is inadequately characterized due to the sparse refuse and insufficient tool assemblage present at the Five Mile Rapids site. After this initial decline, Cressman notes a rich inventory of material extending

to historic times. Diagnostic projectile points change in this period from long triangular stemmed and barbed points to small triangular points. Ground stone and carved stone items appear after 1000 B.C.

Butler's (1959) investigations of The Dalles sites developed data which are consistent with the view of Cressman et al, 1966. Butler (Willey, p. 401) suggests that Altithermal climatic conditions may be correlated with the sparse artifact complex associated with remains from the early Middle Period which he labels Congdon I. This phase would generally align with Cressman's Transition Period (5,000-4,100 B.C.). It is during this period that the influence of the Great Basin desert archaic orientation is postulated. In contrast Jennings (1964) feels that the desert archaic way of life was the dominant life way from about 6,000 B.C.-A.D. 1. Additional archeological research is needed in order to clearly define cultural influences in the Plateau area. The characteristic artifact complex undergoes change after this sparse artifact association. Notable additions to the artifact complex are ground and polished stone forms consisting of paddle-shaped stone mauls, tubular pipes, atlatl weights, two-holed stone gorgets, perforated circular stones, stone pestles and mortars, slate fish-gorges and zoomorphic stone sculptures. It is felt that during this time (1500-1000 B.C.) the Plateau area was influenced by Boreal-Archaic or Eastern Woodland cultures which would account for the influx of new elements which became part of the Northwest Riverine tradition.

The Late Period is distinguished by a number of different regional chronologies all of which show a common association with the overall culture pattern developed in the Middle Period. The interpretation of cultural change during this period remains unresolved. Willey (p. 405) feels that the foundation of the Northwest Riverine tradition was set around 1500 B.C. while Swanson (1962b) feels that the riverine pattern was not set until some 2,000 years later.

In summary, there exists in the Interior Plateau culture area evidence for early human occupation and early refinements in subsistence exploitation. Many questions remain as to the exact nature of cultural development in the Plateau area. There exists evidence for an early riverine orientation with a subsequent sedentary orientation. Archeological remains which are noted in the area are dwelling sites, burial grounds, petroglyphs, and stone and bone artifact assemblages.

Interior Valley Subarea

From the California border to the terminal at Antioch, the pipeline route passes through the California subculture area referred to as the Interior Valley subarea. Prehistoric occupation of the California area may date as early as 20,000 years ago. The influence of the early Big-Game Hunting Tradition is suggested in the remains of the Borax Lake site in northern California. Willey suggests that the earliest culture in California represented a blend of traditions comprised of the Old Cordilleran culture mentioned above and the desert pattern of the Great Basin and refers to the Interior Valley area as the part of the California coast and Valley tradition, which was a favorable hunting-fishing subsistence adaptation. Through time there is archeological evidence for: 1) a notably more efficient ecological orientation, 2) larger sites in later periods, 3) more sedentary existence, 4) larger populations. C.W. Meighan (1959a) characterizes the subsistence orientation in the California Coast and Valley tradition as comprising three basic economic orientations:

a. Primary dependence upon plant seeds and small game;

b. Dependence upon acorns, fish, birds, and larger game animals;

c. A marine economy based on ocean resources.

Artifacts associated with this tradition consist of grinding implements--manos, metates, mortars, pestles--and ornaments such as charmstones, pendants and pipes; atlatl and dart (early); bow and arrow (late); chipped stone artifacts; steatite vessels; baskets; pottery (late); bone objects--fish gorges, awls, whistles, fish spears and wedges; shell ornaments, especially abalone shell.

Within this tradition there is noted an elaboration of artifacts through time, with an increased importance placed on nonfunctional ornaments. The increased emphasis on nonfunctional items relates to changes in social complexity resulting from the development of larger populations, village-oriented political units, warfare and trade.

The prehistory of the Interior Valley consists of three major periods based on Heizer (1964): Early Period, 5000-2000 B.C.; Middle Period, 2000-A.D. 250; Late Period, 250 A.D.-historic horizon. The Early Period in the Interior Valley contains the Windmiller sites. These sites are located on clay knolls in the lower Sacramento Valley. Artifacts recovered from these sites indicate use of both plants and riverine resources. Associated cultural remains consisted of slab metals, bowl mortars, large projectile points, bone fish hooks and gorges; bone trident fish spears; bone awls; daggers, pins, needles and bird-bone tubes. Twined weaving was practiced. Many burials are associated with the Windmiller sites. Internment artifacts consisted of Olivella and abalone beads, chipped stone projectile points, quartz crystals and charm stones.

There was an increase in population during the Middle Period in the Interior Valley, with a continued reliance upon hunting, river fishing and plant collecting, while on the coast a more marine oriented economy is evidenced by the beginning accumulation of large shell mounds. During the Middle Period burial practices changed from the earlier extended form to tightly flexed internments. Cremation was also practiced. There is also noted a decrease in the quantity of burial goods. Fishing gear such as bipointed bone fish gorges and barbed bone fish spears are part of the tool kit of the Interior Valley suggesting line and spear fishing. During the Middle Period bone tools came into increased use. Awls, which are indicative of basket making, are more widely evident. Additional Middle Period remains include circular or rectangular abalone beads, perforated abalone ornaments, ring-shaped and elongated perforated slate ornaments, ground stone beads and spool ear plugs, and baked clay balls used for basket-boiling.

Regional and local differentiation characterize the Late Period. Population growth in the Interior Valley was dense with the sixteenth-century tribes having their roots established early in this period. Environmental exploitation, due to the increase in population, was oriented towards micro-environmental subsistence procurement. Artifactual changes include use of the bow and arrow replacing the atlatl; smaller projectile points; steatite tubular pipes and cooking vessels; increased use of stone and shell beads. The Late Period in the Interior Valley is associated with the Penutian speaking tribes of the area. Sedentary village life was the common pattern with a continued subsistence refinement based on hunting and collecting of riverine and abundant acorn resources.

Historical Background

The early history of the Northwest states is the story of the entrance of explorers, trappers, missionaries and settlers into the region. Early interest in the Northwest region stemmed from a concern of European nations to find a short route through the North American continent--the fabled Northwest Passage. Due to the considerable rivalry for trade supremacy, England and Spain had a major interest in locating a shorter route. The influx of early exploration vessels soon led to the discovery of the Northwest coastal area's fur trade potential. During the eighteenth century, economic interest in fur trade intensified area explorations by Spain, England and Russia. Spain sent an exploratory expedition to the Northwest coast under Juan Perez which sailed past the shores of Washington and Oregon in 1774. The English Captain James Cook's voyage to the Northwest coast area in 1778 opened up the lucrative fur trade which marks the start of intensive exploration in the area. An additional attempt by the British to investigate this area resulted in the voyage of George Vancouver in 1792. It was an American, Robert Gray, who located the mouth of the Columbia River and is credited with establishing U.S. interests in fur trade. Overland investigation of the Northwest was conducted by two English fur companies, the Hudson's Bay Company and the North West Company. Lewis and Clark's 1804-1805 expedition to the mouth of the Columbia River gave impetus to U.S. claims to the region.

Following fur trade developments came missionaries and settlers. The Oregon Trail became a major immigration route by the early 1840's. As American influence and settlements grew there was a corresponding interest in incorporating the area into the U.S. political system. In 1843 Oregon County was organized as a territory and in 1853 Washington Territory was established.

Indian wars are another part of the Northwest region's history. Notable among Indian-settler conflicts are the Cayuse War (1848-50), the Yakimaka War (1855-58) and the Nez Perce War (1877). These wars and numerous smaller hostilities had some detrimental effect on population and economic growth. An additional factor which retarded such growth was the lack of transportation and communication facilities throughout the area. During the 1870's and 1880's the development of these facilities aided in unifying the Northwest.

This history of California basically focuses on the early Spanish influence and the effect of the 1848 Goldrush. Spanish involvement in California dates to 1542, although actual interest in the area was slight until the eighteenth century when pressure for settlement, coming from Spanish missionaries fearing Russian and British influence, resulted in Spanish colonization. Junipero Serra's religious zeal aided in the establishment of 21 missions in the California area which served as the basis for maintaining Spain's influence in California. In 1821 California came under Mexican control and the missions became secularized ranches over a period of years. In the 1840's the slow growth of the American population in California ended. American influence mushroomed with the population as the discovery of gold in 1848 attracted thousands of newcomers to California. By 1850, statehood was granted. Population continued to grow after the initial gold rush spurred by the completion of the first transcontinental railroad in 1869. Cattle ranching ranked second to mining in terms of economic importance up to the decade of the 1860's. During the 1860's wheat replaced cattle as California's most important agricultural product and with the help of state funds, farmers were encouraged to develop the agricultural potential of California. The last half of the 19th Century was a period of tremendous population and economic growth in California based on the percent of farming, mining, and railroad ventures.

2.1.4.13 Recreational and Esthetic Resources

There are 34 recreation sites and areas within a ten mile wide corridor along the pipeline route, as follows: Idaho 6, Washington 8, Oregon 10, California 8. See Table 2.1.4.13-1 for the name and location of these recreation sites and areas, and Table 2.1.4.13-2 for the traffic flow on the major highways crossed by the pipeline. Highlights of the areas are discussed by state.

Idaho

An area of national significance is the Moyie River Valley which is being studied by the Forest Service for potential addition to the National Wild and Scenic Rivers System. The valley contains recreational opportunities normally associated with National Forests, including hunting, fishing, camping, etc.

A variety of wildlife provides hunting in the Purcell Trench basin and the surrounding hills. White-tailed and mule deer are the most plentiful big game although an occasional elk and moose are also harvested. Doves and pheasants provide the principal upland bird hunting, and a variety of waterfowl attracts hunters along the watercourses and around the lakes. Lakes, rivers, and streams crossed by or within five miles of the right-of-way provide excellent fishing opportunities for anadromous and resident fish.

Pend Oreille Lake has produced world record fishing in past years. Moyie and Kootenai Rivers offer particularly excellent fishing with resident trout (especially rainbow) in the Moyie; and cutthroat, rainbow, Dolly Varden, brook, and brown trout, kokanee salmon, whitefish, and stürgeon in the Kootenai. The larger lakes and rivers are also used for boating, water skiing, and swimming.

Washington

Lying one to two miles west of the proposed pipeline between M.P. 200 and 205 is an area on the Palouse River being considered as a Natural Area. It extends from the confluence with the Snake River to Palouse Falls and is under the jurisdiction of the Corps of Engineers.

Horse Slaughter Campsite on the south shoreline of the Spokane River is two miles east of the pipeline crossing. From the Washington-Idaho border to the Snake River the pipeline route lies between and paralled to the Kentucky Trail and Texas Road. The westward bound route of the Lewis and Clark Trail is located at the Snake River Crossing; a mile west is their October 12, 1805, campsite. Lying approximately one-half mile east of the pipeline at the confluence of the Tucannon and Snake Rivers is the site of old Fort Oliver Taylor (1858). Two miles south of the Snake River crossing, the pipeline route crosses the old Mullan Road at M.P. 208.

The entire Snake River gorge in Washington has been identified in the Washington State Recreation Trails Program for water, hiking, and horseback riding trails. Also, State Highway 195, extending almost due south from Spokane, has been designated as a bicycle trail corridor.

Sportsmen hunt the breaks along the Snake River where mule deer is the major big game species. Upland game include Chuckar and Hungarian partridge, valley quail, and Chinese pheasant.

Table 2.1.4.13-1 Recreation sites and areas.

Mile Post	Site & Area Name	Location	Administering Agency	Year	Visits 1/	Visitor Days 2/
		Idaho				
2	Copper Creek	2 Mi. S. of Eastport, ½ Mi. W. of pipeline	U.S. Forest Ser.	1974		9700
12	Meadow Creek	At Meadow Creek on Moyie River ¼ Mi. E. of pipeline.	U. S. Forest Ser.	1974		8100
33	Deep Creek	8.5 Mi. S. Bonners Ferry, 2 Mi. E. of pipeline.	State Park			
68	Round Lake	8 Mi. S. of Sandpoint and 2.5 Mi. W. of pipeline.	State Park	1974	16238	
83	Farragut Wildlife Management Area	5 Mi. E. of Athol	Fish and Game Dept.			
104	Post Falls City Park	Post Falls, 2.5 Mi. N. of pipeline route	City of Post Falls	1974	32468	
		Washington				
109	Horse Slaughter Campsite	2 Mi. E. of pipeline on S. shore Spokane River				
112	Liberty Lake	Near Idaho border, 2 Mi. E. of pipeline	County of Spokane	1974	5300	
112	Liberty Lake Access	Same as Liberty Lake.	State Game Com.			
144	Kentucky Trail	Pipeline Intersects 1 Mi. N. of Rosalia				
207	Lyons Ferry	On Snake River, 2 Mi. W. of Pipeline	State Park	1974	134077	
207	Lyons Ferry Marina	Same as Lyons Ferry	Private Enterprise	1974	21906	
207	Lewis & Clark Oct. 12,1805 Campsite	On S. Bank Snake R. .5 Mi. W. of pipeline				
208	Fort Oliver Taylor	Jct. Tucannon & Snake R's, ½ Mi. E. of pipeline				

Table 2.1.4.13-1 (cont.)

Mile Post	Site & Area Name	Location	Administering Agency	Use Statistics Year	Visits 1/	Visitor Days 2/
		Oregon				
295	Oregon Trail	Pipeline intersects 11 Mi. S. of Hermiston				
466	Lava Butte	12 Mi. S. of Bend, 2 Mi. E. of pipeline	U. S. Forest Ser.	1973	89000	
467	Lava River Caves State Park	12 Mi. S. of Bend, ½ Mi. E. of pipeline	State Parks	1973	64222	
		California				
611	Applegate Trail	Pipeline Intercepts 4 Mi. S.E. of Malin, Or.				
623	Tule Lake Refuge	Near Tule Lake, 4.5 Mi. W. of pipeline	U. S. Fish & Wildlife Service	1973	20034	
663	Mayfield Ice Caves	S.E. Siskiyou Co., ½ Mi. E. of pipeline	U. S. Forest Ser.			
672	Baker Cypress and proposed Primitive area (17,500 acres)	11 Mi. N. of McArthur & 2 Mi. E. of pipeline	U. S. Bureau of Land Management			
672	Non-designated 28,000 acre Roadless area	Pipeline Crosses 11 Mi. N. of McArthur	U.S. Forest Ser.			
678	Eastman Resort	On Eastman Lake, 3 Mi. N. of Glenburn & 2 Mi. E. of pipeline	Private			
679	Metzer Fishing Lodge	On Fall River 3/4 Mi. W. of pipeline	Private			

Table 2.1.4.13-1 (cont.)

Mile Post	Site & Area Name	Location	Administering Agency	Use Statistics Year	Visits 1/	Visitor Days 2/
		California				
687	North Shore	N. Shore Lake Britton, 3 Mi. N. W. of pipeline	Private, PG&E Co.			
687	The Pines	Same as North Shore	Private, PG&E Co.			
687	Jamo Point Boat Access	Same as North Shore	Private, PG&E Co.			
687	McArthur-Burney Falls	S. Shore Lake Britton, 3 Mi. N. W. of pipeline	State Parks	1974	163000	
688	Pacific Crest Trail	Pipeline Intersects, 0.5 Mi. S. E. of Lake Britton	U. S. Forest Ser.			
689	Hat Creek Picnic	On Hat Creek, 1.5 Mi. S.E. of Lake Britton Crossing	Shasta County	1974	32250	
726	Noble Emigrant Trail	Pipeline intersects vicinity of Inwood				
780	Black Butte Lake	10 Mi. N.W. of Orland and 4 Mi. W. of pipeline	U.S. Army Corps of Engineers	1974	161630	

1/ Visit - The entry of any person into site or area of land or water generally recognized as providing outdoor recreation.

2/ Visitor Day - Twelve visitor hours, which may be aggregated continuously, intermittently, or simultaneously by one or more person.

Table 2.1.4.13-2 Traffic volumes.

State	Pipeline Mile Post	Highway	Average Daily Traffic Vehicles
Idaho 1/	0.5	US 95	475
	21.7	US 2	1680
	53.3	US 95 & 2	3112
	61.0	US 2	7100
	66.1	US 95	2900
	83.3	US 95	3500
	85.8	SH 54	350
	96.2	SH 53	2200
	98.1	SH 41	1800
Washington 2/	112.8	IS 90	20700
	124.0	SH 27	5000
	137.4	US 195	4600
	159.0	SH 23	665
	185.3	SH 26	980
	206.5	SH 261	290
	235.0	SH 124	1210
	254.9	US 12	3004
Oregon 3/	285.0	IS 80N	6400
	288.5	SH 207	460
	318.3	SH 74	520
	337.4	SH 19	340
	347.0	SH 206	710
	372.5	US 97	630
	381.0	US 97	730
	423.4	US 26	800
	438.0	SH 126	1550
	454.0	US 20	2350
	487.0	SH 31	440
	505.8	US 97	1900
	510.7	SH 58	1600
	529.5	SH 138	830
	535.8	SH 232	70
	551.8	US 97	2900
California 4/	623.2	SH 139	1050
	690.5	SH 89	1200
	692.3	SH 299	3000
	728.0	SH 44	1400
	743.5	SH 36	1050

Table 2.1.4.13-2 (cont.)

State	Pipeline Mile Post	Highway	Average Daily Traffic Vehicles
California 4/	757.6	SH 99	5700
	761.8	IS 5	11300
	825.6	SH 20	1700
	861.0	SH 16	1250
	872.8	SH 128	3400
	878.2	IS 505	7000
	882.0	IS 80	42000
	998.0	SH 12	3200

Source

1/ State of Idaho, Dept. of Highways, Traffic Comparison Report of Motor Vehicle Traffic on Idaho Highways, 1972.

2/ State of Washington, Dept. of Highways, Traffic Flow Washington State Highways, 1973.

3/ State of Oregon, Department of Transportation, Traffic Flow Oregon State Highway System, 1973.

4/ State of California, Department of Transportation, 1973 Traffic Volumes on California State Highways.

At present Chinook salmon and steelhead trout migrate past the existing pipeline crossings on the Snake River near Lyons Ferry. This migration attracts some fishermen. Resident sport fish include rainbow trout, Dolly Varden, and Mountain whitefish.

Oregon

The Umatilla basin provides excellent waterfowl shooting, while the river and its tributaries contain numerous sport fish.

Along the John Day River breaks, mule deer and Chuckar partridge are hunted; mule deer and upland game species also provide hunting sport in the National forests areas to the south.

The favorable climate, low population, and ready access to recreation and open space lands have drawn many recreationists and retired people to the central Oregon area.

The outstanding geologic feature of Lava River Caves State Park is a lava tunnel 50 feet wide, 35 feet high and one mile long. It and Lava Butte are south of Bend. Lava Butte is an important example of volcanic activity. The pipeline right-of-way crosses the rip zone which extends from East Lake to the crater and the big fissure. When the original pipeline was constructed, archeologists found many archeological specimens in the big fissure, which is about 50 feet deep. On leaving the Bend area, the proposed route crosses the Deschutes and Winema National Forest where a variety of recreational opportunities are provided.

Much of the area from the Oregon-Washington border to the vicinity of Bend, Oregon is privately owned. People having good relations with landowners hunt the perimeter of the wheat fields where Mourning Doves, geese, Chuckar and Hungarian partridge, and ring-necked pheasant provide a wide range of sport for the hunter and the naturalist.

Upper and lower Klamath Lake, Tule Lake, and Clear Lake have one of the largest fall concentrations of waterfowl on the Pacific flyway. This area attracts hunters as well as birdwatchers.

There is an ever increasing recreational use in Oregon of whitewater rivers such as the John Day. These rivers receive considerable pressure from the first of March to the first part of July. Small watercraft such as kayaks, whitewater canoes, and sportyaks are used. Associated with the whitewater sport are the scenic canyon walls and cliffs along the steep John Day Canyon.

Winter sports activities such as snowmobiling and cross-country skiing, are a popular pursuit in the Deschutes and Winema National Forest. Here the higher slopes along the route provide good ski runs.

In Oregon the collecting of rocks and minerals is an important recreational pursuit along the pipeline corridor. Of particular interest to collectors are the deposits of petrified wood found along the upper breaks of the John Day Canyon, and the plum and blue agate thundereggs scattered throughout the area.

Areas of national significance crossed by the proposed pipeline right-of-way in Oregon are:

The Oregon Trail

This migration route to Oregon is being studied as an addition to the National Recreation and Scenic Trail System, and is being monumented in conjunction with the Bicentennial celebration.

The John Day River

Under the Oregon Scenic Waterways system, the segment of the main stem of the John Day River from Service Creek Bridge downstream 147 miles to Tumwater Falls is designated as a scenic waterway. This section is also being studied as a potential addition to the National Wild and Scenic Rivers System.

California

In crossing the southern Cascades the proposed route passes through the Modoc, Shasta and Lassen National Forests, areas of recreational use and recreation oriented residential use. Other recreation sites to the south and within six miles of the proposed pipeline are the Lava Beds National Monument, Mayfield Ice Cave, and the Baker Cypress and Lava Rock Area. In the Fall and Pit River valleys are numerous public and private recreation facilities. Lake Britton is a development of the Pacific Gas and Electric Company where it operates campsites, picnic areas and boat ramps.

The Sacramento River is popular with fishermen and boaters and the State has proposed a canoe trail on the river. Annual runs of anadromous king salmon and steel head attract fishermen to all segments of the river up to the Red Bluff diversion dam. Near Antioch the Sacramento River is a large estuarine stream, providing a variety of sports fishing for striped bass, sturgeon, king salmon, steelhead, and American shad.

Nine and one-half miles east of the Balls Ferry Bridge the pipeline right-of-way crosses Battle Creek, an important stream for the fishery resource.

The Darrah Spring State Fish Hatchery lies upstream two miles and the U.S. Coleman Fish Hatchery lies downstream five miles.

From Willows to Arbuckle the general area provides excellent hunting for ducks, geese and pheasants. Wintering waterfowl populations in the interior valleys and along the California coast run as high as 10 million birds. Hunting in this area is controlled primarily by gun clubs and private landowners.

The San Joaquin River is crossed near Antioch. Being close to a major population center, the San Joaquin River is used heavily by boaters, waterskiiers, and fishermen. Within the California segment of the proposed pipeline corridor, anadromous trout, steelhead, and salmon are the principal cold water sport fish sought, while crappie, black bass, striped bass, shad and perch provide sport for the warm water fisherman.

Areas of National significance crossed by the pipeline in California are: (1) The Pacific Crest Trail, designated as a National Scenic Trail and, (2) The Sacramento River which has been identified as a potential addition to the National Wild and Scenic Rivers System.

Esthetic, Scenic and Cultural Features

Only 5 percent of the pipeline route is designated as having unusual landscape variety, while 60 percent has minimal variety. Likewise, about 60 percent of the route is unseen by the public while 20 percent has high visibility. Table 2.1.4.13-3 shows by segments the classification of the esthetic environment along the pipeline route.

The appendix includes a detailed explanation of the system used to assess esthetic values along the immediate pipeline corridor.

2.1.4.14 Air Quality

Level of Air Pollutants

The polluting materials of principal interest in assessing air quality include nitrogen oxides (NO_x), carbon monoxide (CO), sulfur dioxide (SO_2), hydrocarbons and particulate matter. The standard unit of measurement is micrograms per cubic meter ($\mu G/m^3$), but gaseous pollutants that may occur in relatively high concentration may be expressed more conveniently in units of milligrams per cubic meter (Mg/m^3). The National Ambient Air Quality Standards for these pollutants are shown in Table 2.1.4.14-1.

It should be noted that California uses parts per million (ppm) or parts per hundred million (pphm) for air pollutants concentrations.

The proposed route passes through seven Air Quality Control Regions (AQCR's) as depicted in Figure 2.1.4.14-1. Table 2.1.4.14-2 presents the priority classifications of the seven regions as a function of atmospheric pollutant. Priority I indicates that portions of the AQCR are in violation of the Primary Ambient Air Quality Standard for the pollutant in question, and that significant emission control is needed. Priority IA denotes Priority I classification near one major source only. Priority II indicates pollutant levels in excess of secondary standards but less than primary standards. Priority III indicates that pollutant levels are below secondary standards.

By this criterion, the Idaho, Washington, and Oregon AQCR's along the route are polluted with respect to particulates, while the three most heavily populated AQCR's are polluted with respect to CO, and the two lower AQCR's in California are polluted with respect to hydrocarbons.

Particulate levels along the route often exceed the Ambient Air Quality Standards, for example at Spokane, where geometric means of 75.1 and 78.8 Mg/m^3 were measured in 1974. The source of particulates is probably windblown dust.

In general, particulate levels vary from 60 to 100 Mg/m^3 in the region, and thus the region is sensitive to impacts from particulates. It should be noted that the States of Washington, Oregon, and California have <u>primary</u> Ambient Air Quality Standards of 60 Mg/m^3 for particulates.

Data on other air pollutants in the affected regions are rare, but existing data tend to show that pollutant levels are low except at isolated points. Even in the industrial city of Spokane, the levels of gaseous air pollutants are within the primary standard (See Figure 2.1.4.14-1); the maximum 24-hour SO_2 concentration in 1974, for example, was 172 Mg/m^3 even though the AQCR is Priority I with respect to SO_2 as a result of local industrial concentrations.

Table 2.1.4.13-3 Classification of the aesthetic environment of the proposed route.

Landscape	Pipeline Miles	Class* (Variety/Sensitivity)
Moyie River Valley	19	A1
Moyie Springs to Pend Oreille	36	BI
Pend Oreille Lake	6	A1
Sagle Slough to Purcell Trench	15	B2
Cocolalla Lake	4	A1
Purcell Trench	25	C2
Purcell Trench to Bend, Oregon	351	C3
Liberty Lake	1	A1
Snake River	1	A1
John Day River	1	A1
Bend, Oregon to Kirk, Oregon	93	B1
Kirk, Oregon to Yonna Valley	41	B3
Yonna Valley to Timber Mountain	45	B3
Timber Mountain to Lake Britton	49	B3
Lake Britton to Burney	13	A1
Burney to California Great Central Valley	32	B3
California Great Central Valley	177	C2
Sacramento River	2	A1, B1

* Variety is valued from A (usual) to C (minimal).

Sensitivity is rated from 1 (highest) to 3 (lowest).

Table 2.1.4.14-1 Ambient air quality standards

Pollutant	Federal* Primary	Federal* Secondary	Idaho**	Oregon***	Washington**	California**
Sulfur oxides--						
annual arithmetic mean	80 $\mu g/m^3$	60 $\mu g/m^3$	Same as Federal	60 $\mu g/m^3$	60	
24-hour concentration	365 "	260 "		260 "		.04 ppm
3-hour concentration				1300 "		
Particulate matter--						
annual geometric mean	75 "	60 "	"	60 "		60 $\mu g/m^3$
24-hour concentration	260 "	150 "		150 "		100 "
24-hour concentration****				100 "		
Carbon monoxide--						
8-hour concentration	10 mg/m^3	10 mg/m^3	"	10 mg/m^3	10	10 ppm (12 hr.)
1-hour concentration	40 "	40 "		40 "	40	40 ppm (1 hr.)
Photochemical oxidants--						
1-hour concentration	160 $\mu g/m^3$	160 $\mu g/m^3$	"	160 $\mu g/m^3$		1 ppm
Hydrocarbons-- (corrected for methane) 3-hour concentration (6-9 a.m.)	160 "	160 "	"	160 "		
Nitrogen oxides--						
annual arithmetic mean	100 "	100 "	"	100 "		.25 ppm
Particle Fallout						
industrial areas				10 g/m^2/month		
residential & commercial areas				5 "		
all areas					5 g/m^2/month	
Calcium oxide--						
suspended particulates				20 $\mu g/m^3$		
fallout				0.35 g/m^2/month		
Lead						
monthly arithmetic mean				3 $\mu g/m^2$		
Hydrogen sulfide						.03 ppm

* U.S. Environmental Protection Agency
** State Air Quality Control Agencies
*** Department of Environmental Quality, Oregon Air Quality Report, 1974.
**** Not to be exceeded more than 15% of the time in any calendar month.

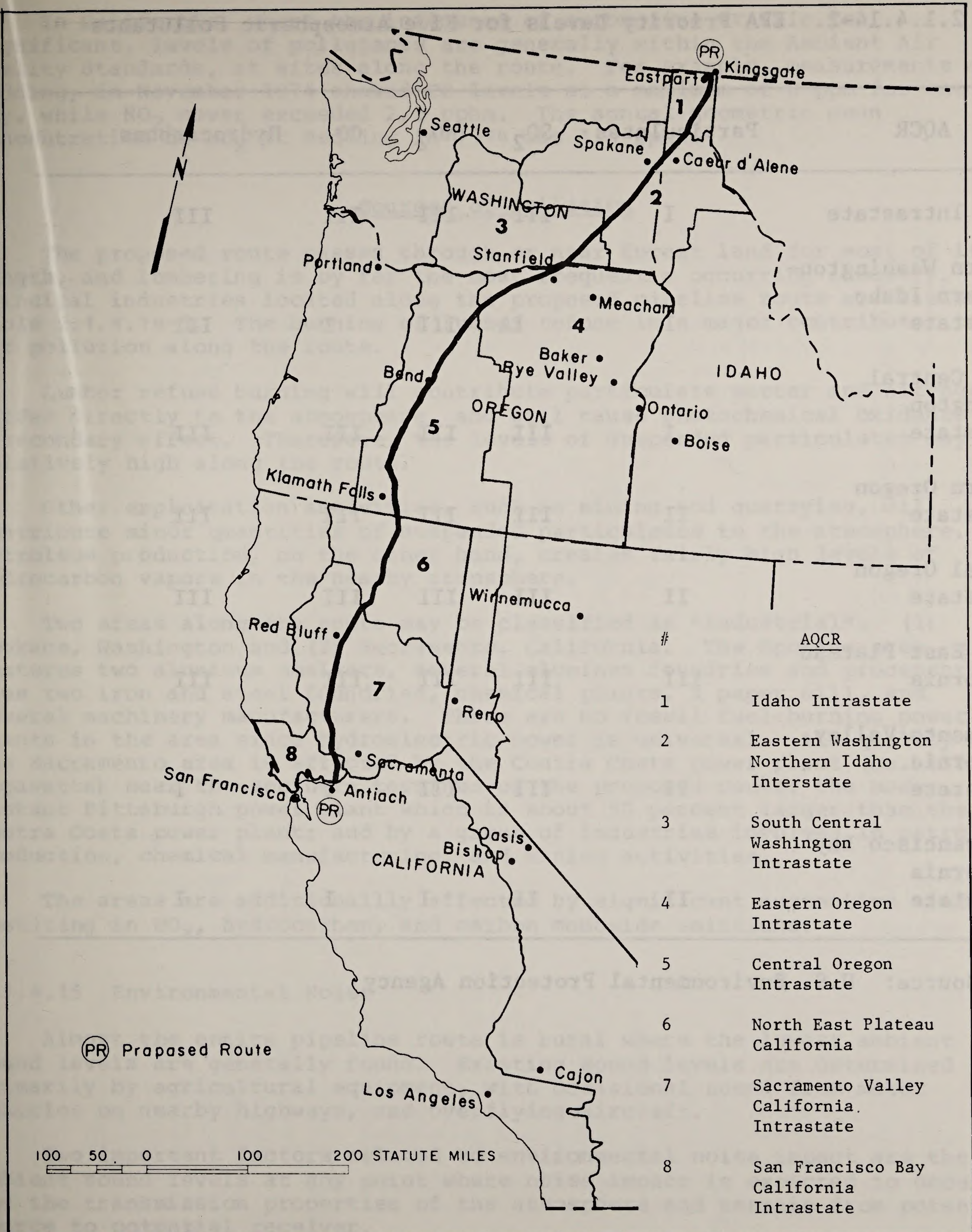


Figure 2.1.4.14-1 Air quality control regions

Table 2.1.4.14-2. EPA Priority Levels for Five Atmospheric Pollutants

AQCR	Particulates	SO_2	NO_2	CO	Hydrocarbons
Idaho Intrastate	I	III	III	III	III
Eastern Washington-Northern Idaho Interstate	I	IA	III	I	III
South Central Washington Intrastate	I	III	III	III	III
Eastern Oregon Intrastate	II	III	III	III	III
Central Oregon Intrastate	II	III	III	III	III
North East Plateau California	III	III	III	III	III
Sacramento Valley, California Intrastate	II	III	III	I	I
San Francisco Bay California Intrastate	II	II	I	I	I

Data Source: U.S. Environmental Protection Agency

In California, where the influence of automotive traffic is significant, levels of pollutants are generally within the Ambient Air Quality Standards, at sites along the route. For example, measurements at Redding, in November 1974 showed CO levels at a maximum of 8 ppm for one day, while NO_2 never exceeded 2.5 pphm. The annual geometric mean concentration of NO_x at Redding in 1974 was 1.8 pphm.

Sources of Pollution

The proposed route passes through or near forest land for most of its length, and lumbering is by far the most frequently occurring industry. Principal industries located along the proposed pipeline route are listed in Table 2.1.4.14-3. The burning of lumber refuse is a major contributor to air pollution along the route.

Lumber refuse burning will contribute particulate matter and nitrogen oxides directly to the atmosphere, and will cause photochemical oxidants as a secondary effect. Therefore, the levels of suspended particulates may be relatively high along the route.

Other exploitation activities, such as mining and quarrying, will contribute minor quantities of suspended particulates to the atmosphere. Petroleum production, on the other hand, creates fairly high levels of hydrocarbon vapors in the nearby atmosphere.

Two areas along the route may be classified as "industrial": (1) Spokane, Washington and (2) Sacramento, California. The Spokane area features two aluminum smelters, several aluminum foundries and processors, plus two iron and steel foundries, chemical plants, a paper mill, and several machinery manufacturers. There are no fossil fuel-burning power plants in the area since hydroelectric power is universal. Air quality in the Sacramento area is affected by the Contra Costa power plant (ca. 1300 megawatts) near the southern terminus of the proposed route; the more distant Pittsburgh power plant which is about 50 percent larger than the Contra Costa power plant; and by a group of industries involved in petroleum production, chemical manufacturing, and mining activities.

The areas are additionallly affected by significant automotive traffic resulting in NO_x, hydrocarbon, and carbon monoxide emissions.

2.1.4.15 Environmental Noise

Almost the entire pipeline route is rural where the lowest ambient sound levels are generally found. Existing sound levels are determined primarily by agricultural equipment, with occasional sound from motor vehicles on nearby highways, and overflying aircraft.

Two important factors related to environmental noise impact are the ambient sound levels at any point where noise impact is expected to occur and the transmission properties of the atmosphere and terrain from potential source to potential receiver.

Ambient Sound Levels

Ambient sound is generally defined as the all-encompassing sound existing at the measurement point due to the sound emitted by all sources in the environment. It is, in essence, the sound heard by a receiver without regard for who or what caused the sound.

Table 2.1.4.14-3 Principal Industries in Counties Traversed by the Proposed Pipeline

State	County	Lumbering	Major Mining	Petro-leum	Power Plants	Pulp & Paper	Smelting	Metal Working	Quarry-ing
IDAHO	Boundary	X							
	Bonner	X							
	Kootenai	X							
WASHINGTON	Spokane	X	X			X	X	X	X
	Whitman								
	Columbia								
	Walla Walla					X			
OREGON	Umatilla	X							
	Morrow	X							
	Gilliam								
	Sherman								
	Wasco	X						X	
	Jefferson	X							
	Crook	X							
	Deschutes	X							
	Klamath	X	X						
CALIFORNIA	Modoc	X	X						
	Siskiyou	X							
	Shasta	X	X			X			X
	Tehama	X							
	Glenn								
	Colusa							X	
	Yolo								
	Solano			X					
	Contra Costa	X	X	X	X				

The ear responds to a range of frequencies from about 50 cycles per second to 15,000 cycles per second (the audio frequency range).

The widely accepted scale for accomodating this fact in environmental noise measurements, is called "A-weighting," and is referred to as dB(A). A more recent scale developed by the Environmental Protection Agency is called the Energy-Equivalent Sound Level (L_{eq}). It is the steady sound level in dB(A) which has the same amount of energy as the actual fluctuating sound level when averaged over a specified time period. A further refinement of this scale has been developed: it is called the Day-Night Average Sound L_{dn}). It is a special 24-hour average of L_{eq}. These measures will be used in this assessment.

Much of the route is rural, with several stretches that parallel highways. Based on rural data provided for the Northern Border pipeline one can estimate the ambient sound levels to be as shown below:

Location	L_{90}	L_{10}	L_{dn}
Rural - Desert	25-35	35-40	35-40
Rural - near highway	30-35	50-60	50-55
Near communities	45-50	60-70	55-65
Near station 5*	34-36		

*Actually measured

Note that these levels are quite low, reflecting the fact that the route is relatively undisturbed by noise intrusion by machines except near highways.

Transmission Properties

The ability of sound to propagate from a source to a distant receiver will depend upon the micrometeorological conditions along the path. In a perfect medium with no absorption or reflection, the sound level would decrease 6dB for every doubling of distance or 20dB for every tenfold increase in distance. For example, a sound level of 80 dB(A) at 100 feet from a source would be 74db(A) at 200 feet and 60dB(A) at 1,000 feet. In the actual air, the micrometeorological and ground conditions will cause what is called "excess attenuation," so that the sound will diminish more rapidly than 6dB per doubling of distance. These conditions are: (1) temperature gradients, (2) wind gradients, (3) wind direction, (4) humidity, (5) surface growth such as grass or trees, and (6) ground level changes.

Wind creates a shadow zone upwind of the source where the sound may attenuate up to 26dB per distance doubling and concentrates sound downwind where it may attenuate at 9dB per distance doubling. In other parts of the proposed pipeline, there are farmlands and tree groupings which would have a greater effect on sound propagation than wind. Large stands of mature trees can be expected to provide an excess attenuation of about 5-7 dB provided the stand is 40-50 feet high and 100-200 feet in depth and the receiver is 200-400 feet behind the stand.

The condition for attenuation is assumed to be one with no wind, with propagation over grass covered level fields for peak frequencies near 100 Hz. For this case the total attenuation starting at 100 feet is expected to be as shown on page 238.

Distance, Feet	100	200	400	800	1,000	2,000	4,000
Attenuation, dB	0	6	13	19	23	32	44

In much of the countryside traversed by the proposed pipeline, the contour is sufficiently gentle so that little shadowing is afforded.

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3 ENVIRONMENTAL IMPACT OF THE PROPOSED ACTION

3.1 ARCTIC GAS PIPELINE PROJECT

3.1.4 San Francisco Pipeline

Introduction

Determination of impacts on the environment that will result from construction and operation of the proposed project involves consideration of several variables that cannot be predicted with certainty. The exact pipeline route location, detailed engineering design specifications, specific construction procedures, weather during the construction period, and rehabilitation techniques are determinants of impact that are not fully known at this stage of project planning.

In this section, impacts are specifically identified and quantified where available information permits. Where variables are involved, ranges of impacts are indicated.

Abrupt alteration of an existing environment will cause long- or short-term impacts on the biomass and the normal interrelationship of components within ecosystems. These impacts may be beneficial or adverse, significant or negligible, chronic or acute. Primary impacts may give rise to further, secondary effects.

In this study, impacts on the environment and resources are considered in view of the total paralleling of an existing pipeline, except for the John Day River area. That is, the proposed project disturbs approximately 1,150 acres of land not previously dedicated to constructing and maintaining the existing parallel pipeline. This acreage is spread over 917 miles. Consequently, the impacts on living and non-living components, ecological interrelationships, and human values that are expected to occur under the proposed action will be minimal.

Summary of Impacts

The more significant adverse impacts which will result from construction and operation of the pipeline are:

1) The removal of vegetation on 1,150 acres of new right-of-way and on approximately 7,000 acres of existing right-of-way. This action will result in accelerated soil erosion by both water and wind, causing disruption of both terrestrial and aquatic biota.

2) The excavation and subsequent backfilling of the pipeline trench will result in reduced soil productivity over the pipeline trench. This will be caused by the compaction and mixing of the topsoil with subsoils.

3) The risks of pipeline rupture resulting from unpredictable seismic events must be considered a hazard which could cause serious adverse impacts on man's environment. This is especially significant over the southern 120 miles of the proposed pipeline right-of-way, which lies in a high seismic risk zone.

Certain favorable economic impacts will be realized by the construction and operation of the pipeline:

1) There will be a continued supply of natural gas to the Applicants' 2,500,000 customers.

2) Counties over which the pipeline is constructed will receive increased annual revenues from property taxes generated by the proposed pipeline.

Also, two additional desirable features of the proposed pipeline are:

1) Its use of an existing natural gas pipeline right-of-way and facilities precludes the expense and adverse impacts if a new alternative pipeline route were constructed.

2) The Applicants' flexibility of design using both the existing and proposed pipelines allows for the construction of one of four pipelines which could accommodate a range of volumes of natural gas which have yet to be determined.

3.1.4.1 Climate

Extremes of climate will adversely affect pipeline construction activities. With the frost line depths varying from 36 to 48 inches in the northern segment of the route, winter or early spring trenching will be more difficult. Spring in the lowland areas, especially in a wet year, will necessitate crossing many waterlogged areas where heavy equipment will be difficult to operate and where the trench will quickly fill with mud and water. Operation of heavy equipment in wetlands and flood plains during wet periods will tend to compound soil compaction and vegetation destruction. This will additionally disturb the natural environment resulting in abnormal erosion, siltation, and rutting of the ground.

Construction of stream crossings during the spring runoff period will face the hazard of freshets which will quickly fill underwater trenches and make the flood plain unusable by heavy equipment.

There will be variations in the ground temperature during pipeline operation which will cause the microclimate immediately above the pipeline to be different from the surrounding area. This will vary depending on distances from compressor stations. The ground above the pipeline will be warmer than surrounding ground temperatures. Consequently snow on the pipeline will melt earlier than in surrounding areas. This affects the environment immediately along the proposed route in a manner similar to a minor change in climatic conditions. These effects would be limited since the existing pipeline has already modified the climate along the right-of-way.

Climatic extremes increase the stresses to which the pipe and welded joints are subjected. However, climatic extremes have not disrupted the existing pipeline. Where erosion, mass wasting, mudslides and streambed scouring results from heavy rains and the pipeline bedding is disturbed or the pipeline is exposed, major stresses can be involved.

The erosion of soil by wind and water, and the acceleration of runoff on disturbed areas will adversely affect the microclimate of soil organisms at or near the right-of-way surface.

The proposed pipeline will not have a significant impact on the climate.

3.1.4.2 Topography

Introduction

Impacts on topography will result directly from construction activities and indirectly from acceleration of natural processes that cause erosion and sedimentation, landslides, rockslides, and rockfalls. The 14 years of experience gained from the existing parallel pipeline will aid greatly in construction, particularly in areas of potential landsliding and other slope failure.

Impacts could be expected from wind erosion, water erosion, and erosion caused by construction activities.

Effects of Wind Erosion

The wind will erode loose soil materials along the right-of-way. This material will be susceptible to wind erosion largely due to the destruction of the natural vegetation cover; partly because of the grinding and churning of equipment wheels and tracks; and partly because the orientation of the proposed route is nearly parallel to the prevailing wind direction. The activity of equipment will break down the larger fragments of soil and earth materials to finer particle sizes which could be eroded by the wind. Wind erosion will have considerably more effect on the topsoil than on the subsoil earth materials.

Despite the estimated potential of 32,500-ton/year erosion of soil by the wind involving about 388 miles of right-of-way, its impact on topography will be negligible; the only expected damage is slight drifting in ditches and along fence lines.

The probability that wind erosion of sand in sandy soil areas will expose the pipeline to external damage is small. The possibility exists but the likelihood is small to negligible, that wind erosion will remove enough sand to cause serious loss of pipe support. If not corrected, lack of support would cause stresses within the pipe that could lead to pipe failure.

Effects of Water Erosion

The normal rate of erosion by water would be increased along the right-of-way because of the absence of vegetation and pulverized character of the surface soil which would be caused by the wheels and tracks of equipment. Surface water will erode loose topsoil very readily and subsoil materials less readily because of their generally greater particle size.

Accelerated erosion of the subsoil by surface runoff will occur where the topsoil was removed previously by erosion. The result would be gullying of slopes and increased cutting by small streams with accompanying reduction of vegetation and crop yield. Some of the eroded soil materials would be deposited downslope which would tend to build alluvial fans. These fans also reduce agricultural production by their inundating the vegetation in the fan area--an area which could be a few feet or 100 yards across.

The possibility exists, but the likelihood is small, that accelerated surface runoff would remove enough soil material to cause serious loss of pipe support. If not corrected, lack of support could cause stresses in the pipe that could lead to pipe failure.

Effects of Blasting

Blasting to facilitate excavation will probably be necessary particularly in the walls and floors of valleys and in places on the upland ridge. Blasting will probably be negligible as a factor in causing new landslides or renewed movement of now-stable landslide masses. It is possible that a mass of claystone, shale, or siltstone that is on the threshold of slope failure might slide from the effects of blasting.

Recontouring of Slopes

Cuts and fills to establish a level working surface for construction and maintenance activities on slopes crossed perpendicularly (lengthwise) by the pipeline will result in recontouring the slopes. Because steep slopes traversed by the proposed pipeline route are generally limited to stream valleys which are crossed perpendicularly, cuts and fills for right-of-way leveling would be largely restricted to the moderate slopes of the upland areas. Thus, recontouring for right-of-way leveling will be limited in degree and extent, depending upon the actual pipeline alignment.

Disposal of surplus excavated material from trenching and backfilling in centrally located piles scattered at sites adjacent to the proposed route will also result in recontouring. The size of the piles will depend on the volume of the excess excavated material.

Other Impacts

Permanent changes in the land surface will result from (1) the crown of soil material over the trench backfill, (2) the foundation and drainage pads for structures, (3) those locations where the trench cannot be fully backfilled, (4) the disposal of surplus soil in piles adjacent to the pipeline right-of-way, and (5) the cuts and fills for right-of-way leveling.

The crown of spoil over the pipeline presumably will be as wide as the trench, and the crest will stand several inches above the general surface of the land adjacent to the right-of-way. In profile the crown thus will be convex. With time this crown will essentially disappear, and may actually be replaced by a similar form that is concave. The change in profile of the crest will be caused by the natural settlement of the loose backfill in the trench. Considering the slow rate at which settlement takes place in dry regions, the crown locally could last for many years.

In a few situations, it may not be feasible to fully backfill the trench. For example, a near vertical valley wall or highway cut with layers of hard rock exposed would presumably have a vertical trench cut into the wall to receive the pipeline. The trench would not be filled completely and so would be apparent for the life of the pipeline. Presumably it would serve as a drainage channel for surface water runoff along the surface of the backfill and ground water flowing through the backfill.

Construction of the 1960-61 pipeline resulted in only minor topographical impacts. The proposed pipeline will occupy the same right-of-way area except for a 21.4-mile segment across the John Day River. Therefore, construction of the proposed pipeline should not add significantly to the adverse impacts previously made upon the topography.

3.1.4.3 Geology

The impact of the proposed pipeline on the geologic environment will probably be negligible, but the interaction between the proposed pipeline system and the geologic environment could be significant. If geologic processes caused the proposed pipeline to fail, the resulting impact on the surrounding total environment could be significant. It is felt that existing geologic evidence points toward a possibility that one or more geologic processes could cause the proposed pipeline to rupture during its lifetime. Because of this, many of the comments on the geology-pipeline interrelationship in the province-by-province discussion that follows are directed towards pointing out specific areas where the various geologic processes operating may pose a threat to the proposed pipeline.

Effect on Present and Future Mineral Resources and Production

The impact of the proposed pipeline on currently active mineral production along the route will be minor. Construction materials are readily available along most of the route. However, the pipeline may hamper future exploitation of small portions of some economic mineral deposits.

The potential for discovery of new mineral resources due to trenching for the pipeline is small, because of the shallow depth of the trenching (less than 10 feet) and exposure of bedrock for less than 20 percent of the proposed route. Some useful definition of occurrences of clay, sand, and gravel and other potentially economic surficial deposits might result.

Effects on Surface Drainage and Terrain

All disruption of surface drainage should be temporary, occurring only during construction. Terrain scars would be caused by extraction of construction materials (sand, gravel, volcanic cinders, clinker, etc.) and unless filled, would be permanent features of the landscape.

Potential for Effects on Pipeline by Geologic Hazards

Seismicity and Faulting

Segments of the proposed route, especially in northeastern Oregon and central California, are included in zones of significant potential future seismicity and possible ground failure. Approximately the southern 120 miles of the route are located in seismic risk zone 3 (major damage corresponds to intensity VIII and higher of the Modified Mercalli intensity scale). The remainder of the route, except for approximately 140 miles in southern Oregon in seismic risk zone 1 (minor damage), is located in seismic risk zone 2 (moderate damage). Specific areas subject to ground liquification are described in the following sections.

Slope Failures

Slope failures of a wide variety, including: landslides, rockslides, mudflows and debris flows, would be a potential hazard over much of the proposed route. Even in areas not in a high risk seismic zone, ground shaking sufficient to initiate landslides could be possible. Areas with the highest potential for landslides that are a threat to the integrity of the proposed pipeline are located in: the Moyie River Valley, near Antelope Creek in the Columbia Plateau province; in the John Day Formation,

immediately south of the Columbia Plateau province; south from Cow Creek in the Modoc Plateau province; and in the Tuscan Formation, near the Sacramento Valley.

Volcanism

Volcanic eruptions are a possible threat to the pipeline at several localities along the route, most notably in southern Oregon and northern California. The potential for rupture comes from flows of hot volcanic ash and mudflows (lahars) as well as lava flows.

Flash Floods

Flash floods have a large potential for damage to the proposed pipeline. Bank (lateral) erosion, streambed (vertical) scour, and transportation of extremely coarse sedimentary detritus could cause pipeline damage.

Subsidence

Pipeline failure by ground subsidence could occur by collapse of lava tubes in the Modoc Plateau province.

Northern Rocky Mountains Province

The impact on the geologic environment caused by construction and maintenance activities related to the proposed pipeline would be minimal in the Northern Rocky Mountains province. Terrain scars caused by extraction of an unquantified amount of sand and gravel for construction material would be apparent.

If procedures are taken to restore the local topography along the proposed route to its pretrench configuration, disruption of surface drainage would be apparent only during construction. Piling of excess spoils in small drainages could cause local ponding or diversion of small or intermittent streams.

If the proposed route crosses relatively unweathered outcrops of the Sandpoint Conglomerate in the Purcell Trench, trenching difficulties could be encountered. This unit is well indurated in places and contains boulders up to several feet in diameter that could require blasting. The erosional knockers of granitic rock, quartzite beds and diorite sills of the Prichard Formation locally could also require blasting. On the south side of Spokane Valley, the proposed right-of-way crosses several small areas of metamorphic rocks. Although these are crystalline rocks, weathering is fairly deep in most of the area and trenching difficulty should not be encountered.

At present, sand and gravel account for almost all of the known mineral resources within a reasonable distance of the proposed pipeline in the Northern Rocky Mountain province. This commodity is so plentiful that any borrow pits closed by laying of the proposed pipeline would not cause any local shortages.

There would be no significant disruption of subsurface drainage, since most of the proposed pipeline is in highly permeable, relatively uniform glacial alluvial material.

The seismicity, of that part of the Northern Rocky Mountains province traversed by the proposed pipeline would be located in seismic risk zone 2. This indicates that no shaking due to earthquakes will exceed intensity VI along the proposed route. Also, there are no known faults that cut Pleistocene deposits in this region.

In the Moyie River Valley, particular combinations of slope steepness, dip of beds, and lithologic character could give rise to landslides or other forms of slope failure. Undercutting in some of these areas could make the rocks even more prone to failures. At present, detailed geologic maps are not available for this region. A more complete discussion of landslide potential in this area is given in the section on Northern Rocky Mountains province, geologic hazards Section 2.1.4.3.

The impact of the proposed pipeline on currently active mineral production in the Northern Rocky Mountains would be low or zero.

Clay pit operations are sporadically active in the region around Freeman, Washington. Large quantities of high quality clay lie beneath the Palouse Formation. Through most of this area, trenching for the proposed pipeline would not expose clay, but could hamper future exploitation of these deposits.

In recent years, considerable attention has been given to large, low-grade occurrences of copper in formations of the Belt Supergroup. To date, none of these occurrences has been found in the Prichard Formation, the Belt unit traversed by the proposed pipeline. There are no indications that the area around the proposed pipeline might be more promising for this type of deposit than other areas.

Columbia Plateau Province

Disturbances of the geologic environment caused by construction and maintenance activities should be minimal in the Columbia Plateau province with a few possible exceptions of potential earthquake and earthquake-related damage to the pipeline.

Small slides and slumps could be expected on steep loess hills at various places in this province. Specific identification of these areas would depend on a detailed soil survey on the final route location. Tests have not been made to determine the maximum slope angle at which these loess hills are stable with regard to slumping. Slides or slumps could move the proposed pipeline or remove support. If this movement or removal of support is great enough, the proposed pipeline could break. In areas of low slopes, the loess would be excellent material for pipeline laying purposes as it is easily excavated, has uniform properties, and is well drained.

The Palouse, Snake, Touchet, and John Day valleys, are also susceptible to sliding. Talus cones of basaltic debris occur along the Snake Valley and would be avoided because of their instability. A loose rock slope, such as a talus cone, is subject to movement due to a number of reasons, such as: 1) undercutting of the base by natural erosion or excavation by man; or 2) shaking due to an earthquake. The action on the proposed pipeline would be similar to that described for slumps or slides.

The proposed pipeline in the Columbia Plateau province is in seismic risk zone 2 except for a small part in seismic risk zone 1. These are described in Figures 2.1.4.3-5 and 6. Two moderate earthquakes, both intensity VII, have occurred in northern Oregon near the proposed route. The event closest to the proposed pipeline occurred March 7, 1893, at

Umatilla, about 10 miles northwest of the proposed route. On July 6, 1936, a magnitude 5.75 earthquake was centered near Milton-Freewater about 20 miles southeast of the proposed route. (See Section 2.1.4.3 for discussion of seismicity in this region.) This general area is near the eastward projection of the Wallula Gap fault.

The Wallula Gap fault forms part of the Olympic-Wallowa lineament, a major topographic lineament in the Pacific Northwest, although it is not known if this lineament is controlled by a major, through-going fault system. The presence of known faults, such as the Wallula Gap fault, suggests that this possibility should be considered before construction across the lineament. The earthquake at Umatilla, and the earthquake and associated ground cracking near Milton-Freewater, suggest that, whatever the nature of the Olympic-Wallowa lineament, northeastern Oregon should be considered an area of potential seismicity and possible ground failure.

Should an earthquake capable of producing severe ground motion occur, two areas could be expected to be susceptible. One is where the proposed pipeline crosses Pleistocene Lake sediments near the mouth of the Walla Walla River. These sediments are fine-grained and saturated during winter or periods of high rainfall or flooding. They could experience liquefaction due to strong shaking during a major earthquake. If this should occur, foundation support for the proposed pipeline would be removed and it would behave as if it were in a liquid. Rupture of the proposed pipeline could occur. The other area is where the proposed pipeline crosses landslides on the John Day Formation near Antelope Creek. A large earthquake could trigger further sliding, especially during a wet season. If this occurred, the proposed pipeline could move with the landslide. The material in which the proposed pipeline would be buried could also slide away and leave the pipeline unsupported. In either case, the proposed pipeline could rupture. Elsewhere, drainage appears excellent through the permeable loess and basalt, and severe ground motion or liquefaction would occur only under unusual circumstances.

There is no historically active fault, documented on the basis of primary fault features within 100 miles of the proposed pipeline across the Columbia Plateau.

Where the loess blanket thins in the southern part of the province, extensive blasting could be required in the basalt bedrock. Terrain scars could be minimized by careful restoration along the trench and by using existing borrow pits for needed construction materials. Siltation at stream and river crossings, and disruption of surface drainage would occur temporarily during construction.

The impact on present and future mineral resources exploration and production in this province would be minimal. Other than aggregate material, there are no known mineral resources in the proposed pipeline area and the potential for discovery of additional resources is small. The aggregate is of two types: basalt, derived from the highly jointed Yakima flows; and sand and gravel, present in the flood deposits. There are numerous borrow pits of each type, but basalt pits predominate. All pits are small, and most are used for only one specific job and then abandoned. The proposed pipeline would not affect, or be affected by, the utilization of this aggregate material.

Blue Mountains Province

Disturbances caused by construction and maintenance could initiate new landslides or reactivate older ones. If the proposed pipeline were buried

in one of these landslides, it could rupture. Landslides are common where the Clarno and the John Day Formations crop out. Most of these slides probably reached their peak activity during the Pleistocene age when climatic conditions were wetter than today. Many slides are still active and others could be so unstable that trenching could reactivate parts of them. Most of the landslides active today creep nearly continuously, with accelerated periods during times of high rainfall or high rate of snow melting. Areas most susceptible to sliding are those in which the bentonitic tuffs of the John Day Formation are tilted and overlain by Columbia River Basalt. If lateral support is removed from such areas, either naturally or artificially, landslides very commonly result, especially during wet periods. The area of landslides where the proposed pipeline leaves the Columbia Plateau and enters the John Day Formation is a good example and is shown in Figure 2.1.4.3-2.

Known seismicity in this province is low. However, ground shaking from distant earthquakes could cause intensities of IV or V and could reactivate or initiate landsliding.

Terrain scars caused by use of the construction materials could cause minimal problems from oversteepened slopes. Disruption of surface drainage should have only minor impact during the construction period, and disruption of subsurface drainage probably would not occur.

There would be no adverse impact on present or future mineral exploration or production in this province.

High Lava Plains Province

Construction of the proposed pipeline along this section would not have a significant geologic impact because it would follow the route of an existing gas pipeline. Access roads for the existing pipeline have been developed and few new roads would be necessary. Terrain scars would largely be in areas already disturbed by construction and maintenance of the existing line. Most of the proposed route would be visible only from nearby locations because of the Juniper covered, irregular topography in the northern part of the province, and forests contiguous to the southern part of the province.

Large quantities of construction material would be available along the proposed route, in the form of crushed rock from basalt flows and cinders and scoria from nearby cinder cones. Trenching for the proposed pipeline would necessitate considerable blasting along much of the route because basalt flows crop out at the surface or have only a thin veneer or ash or loess. Blasting in the area near Lava River Caves could cause damage to the part of the cave that is open to the public west of the route or to the closed part of the caves that probably underlies the proposed route.

Localized flooding along small ravines on the west flank of Newberry Volcano, during intense summer thunderstorms, could excavate the pipeline. The debris carried in the floods could rupture the proposed pipeline. Construction of the proposed pipeline would probably have little impact on slope stability in the area and would not likely cause accelerated erosion.

Eruptions of basalt, less than 1,970 C^{14} to 6,000 C^{14} years B.P. (before present), along the Northwest Rift Zone of Newberry Volcano and concurrent faulting along this zone indicate that this part of the proposed route is volcanically and tectonically active even though no seismic activity is recorded there. This activity has spanned the last few thousands of years and there is no reason to suppose that it could not recur

in the near future. If eruptions did occur, the proposed pipeline could be covered and/or broken by lava flows or by faulting and fissuring accompanying eruption. Ash flows in excess of 20 feet thick could also cover the proposed pipeline in the vicinity of Newberry Volcano.

Cinders and scoria from many of the small cinder cones near the proposed route would be used for road construction. Basalt from flows has locally been used for building material. Because deposits of this material are so abundant in the general region, removal of availability due to the proposed pipeline construction would have little or no effect on local needs.

Basin and Range Province

The proposed route follows an existing pipeline. Therefore, access roads are available to much of the route, and terrain scars would largely be confined to the area where previous construction has already taken place.

Crushed rock, cinders, and scoria are currently mined at various places along the route and few new sources would need to be developed. Due to the thin cover of surficial deposits, burial of a relatively large part of the proposed pipeline would require blasting. Upper Tertiary sediments in the southern part of the route could largely be trenched by using excavation equipment.

Ravine, stream, and river crossings would require either suspension or deep burial of the proposed pipeline. Therefore, there would be no interference with surface water runoff during the occasional intense summer thunderstorms that occur in this area. Runoff during these periods could be of such intensity that they could excavate the proposed pipeline if it were not deeply buried. Debris carried by the flow could rupture the proposed pipeline. Any major modification of the surface in some valleys, such as Long Valley near Milepost 490, could cause ponding of surface water because of the high water table. Some parts of the proposed route near Sprague River and Yonna Valleys are underlain by semiconsolidated upper Tertiary sedimentary rocks. These could be subject to landsliding on steeper slopes particularly where overlain by basalt flows as between Mileposts 567 and 570. If the proposed pipeline were buried in one of these landslides, rupture could occur if the slide reactivated. The available description of the proposed route is presently insufficient to determine the exact pipeline route relative to slopes in these areas. However, the route should avoid traversing steep slopes as much as possible.

No historic scarps are recorded along the proposed route, nor are faults known to offset Mazama ash or Quaternary alluvium. Nevertheless, much of the faulting in the region is of Pleistocene age. Nearby areas to the west (Klamath Graben) and east (Lakeview) are seismically active, so that renewed movement of faults along the proposed route cannot be discounted. Any near-future volcanic activity in the area would most likely be confined to the adjacent Cascade Range. Even though some of the volcanic activity in this part of the Cascades is of Holocene age (i.e., eruptions from Mount Mazama, 10 miles east of the proposed pipeline, occurred 6,600 years ago and since), no historic eruptions are recorded. Eruptions that were sufficiently broad in their impact to affect the proposed route would cause significant damage to nearby structures as well. Damage would most probably come in the form of hot volcanic ash and mudflows that would cover the proposed pipeline.

The mineral potential of this segment of the proposed pipeline is relatively low and construction would not significantly affect future

exploration or production. Pumice and diatomite deposits that would be traversed by the proposed pipeline crop out over large areas. Removal of any amount needed for the proposed pipeline construction should have little impact on their future development in the region.

Modoc Plateau Province

The region that would be traversed in this province is one of active volcanism. Historic eruptions within 25 miles of the proposed route have occurred. (See Section 2.1.4.3, geologic hazards, for discussion.) The short record indicates eruptions within 25 miles of the proposed route in California have been recurring at intervals averaging perhaps 50 or 100 years, although it is not possible to state that another eruption will occur 50 to 100 years since the last one. A distant eruption of ash could blanket the proposed route but probably would have little effect on a buried pipeline. More destructive possibilities include hot ash flows and especially volcanic mudflows (lahars). Destructive lahars with erosional potential could follow streambeds and cut the proposed pipeline if a winter eruption would occur near the (post-glacial) Burney Mountain Volcano or in the Lassen Peak area. Lahars or ash flows could occur with advance warning of less than 1 day. If the proposed pipeline were buried by lava flows, it would be inaccessible to repair. It is not known if the increased load could stress the proposed pipeline to the point of rupture.

Landslides are common on dip slopes from Cow Creek south, especially in the Montgomery Creek Formation (McDonald and Lydon, 1972). The proposed pipeline crosses a landslide on the north slope of North Fork Bear Creek, mapped by MacDonald and Lydon (1972). Trenching could initiate movement on this or smaller unmapped landslides. Large landslides and associated surface faulting could be encountered in the Tuscan Formation, near the Sacramento Valley, due to failure in the underlying Montgomery Creek Formation. Such landslide movements could be large. If the proposed pipeline is buried in one of these features, rupture could occur with movement.

Local subsidence could be a problem where the proposed route crosses pahoehoe lavas because of the potential collapse of numerous lava tubes and cavities. See discussion in Section 2.1.4.3, geologic hazards.) Tubes could also collapse after the proposed pipeline is laid, especially during earthquakes. Blasting during construction could weaken the rocks around cavities and hasten their subsequent collapse.

Historic surface faulting in the Modoc Plateau province has not occurred (see discussion in Section 2.1.4.3, geologic hazards).

The areas underlain by Quaternary lake beds would be subject to liquefaction during severe ground shaking. If this should occur, foundation support for the proposed pipeline would be removed and it would behave as in a liquid. Rupture of the proposed pipeline could occur. These lake bed deposits are found along the proposed route just south of the Oregon border and at the crossing of the Fall River.

Construction materials would be available along most of the proposed route and impacts here are the same as previously described.

There should be no immediate impact on present mineral exploration and production. If development of potential resources is attempted, a few could be affected in the future, because mining operations would avoid the vicinity of the proposed pipeline. Potential resources along the proposed route include geothermal power, diatomaceous earth, pozzolan, decorative

stone, and coal. The effect of the proposed pipeline on future development of any of these potential mineral resources cannot be ascertained at this time. (See Section 2.1.4.3, mineral resources for discussion of individual commodities.)

Great Valley Province

Seismicity of Yolo and Solano Counties, through which the south part of the proposed route would pass, is high. In the event of a large earthquake, major damage to most man-made structures due to shaking is likely. Historic earthquakes likely to have affected the proposed pipeline have occurred in the San Andreas, Hayward, and Concord fault. However, there are a number of other faults of unknown seismic potential in the areas, as well as some earthquake epicenters not yet associated with ground breaks (see Section 2.1.4.3, geologic hazards, for discussion of seismic potential).

Many of these faults have the potential to generate earthquakes that would cause the proposed pipeline to rupture, by ground shaking, displacement along the fault trace or secondary surface displacements due to shaking.

Areas most likely to suffer from liquefaction during earthquake shaking are those low-lying areas south of Dozier and north of the Montezuma Hills, Sherman Island (which is 12 or 15 feet below sea level), and the area underlain by bay mud that borders the San Joaquin River (Sims and others, 1973). Areas of lower liquefaction potential are in the Montezuma Hills, areas underlain by Quaternary stream deposits and terrace deposits, and in stream and terrace deposits associated with Cache, Putah, and Eulatis Creeks and their tributaries. Slope failures could probably be expected on even moderate slopes at most of these localities. Sherman Island has dikes that surround this island that would probably fail because the surface of the island is below sea level.

3.1.4.4 Soils

Of all the natural physical resources affected by the proposed project the disturbance of the soil will create the most significant impacts, directly or indirectly, to the environment.

The destruction or reconstitution of the life-supporting topsoil will interfere with the natural processes of the functional ecosystems through which the pipeline passes. The loss or dilution of topsoils on agricultural lands will cause lasting reductions in crop production. The exposure of topsoils by removal of the vegetation will allow erosion from wind and water. Eroding soil particles will provide particulates that will contaminate the air and sediments to pollute streams.

In addition to impacts on the construction site there will be offsite disturbances from the excavation of bedding material and disposition of surplus materials from the pipeline trench. The quantities of these materials cannot be assessed until construction begins or detailed surveys are made. Likewise, the quality of subsoils and substrata materials to be excavated are not known for specific areas to be crossed by the project.

The purpose of this section is to discuss the soil related impacts that will occur as a result of implementing the proposed project. Although precise quantifications are not possible the relative impacts anticipated or the range of losses to be expected are discussed.

Descriptions of the soil series likely to be encountered along the pipeline route are contained in section 2.1.4.4. These descriptions have been interpreted in this section to determine the critical areas of soil related impacts that are likely to occur with project implementation.

Contamination of Topsoils by Excavation of Subsoils

As described in Section 2.1.4.4 the proposed pipeline will cross many types of soils. As indicated in the Section 2.1.4.4 tables, the topsoil varies from 1 to 6 inches thick in forested areas and from 6 to 20 inches in grassland and agricultural areas. Topsoil or the "A" horizon is the organically enriched layer that has accumulated through many years of soil formation. In agricultural areas the topsoil has been further enriched with fertilizers and manure applied by the farmer. The topsoil supports the soil micro-organisms so important to the nutrient cycle of the soil ecosystem.

The Applicant's mitigation statement indicates that topsoil will be stockpiled and returned to the surface of the trench in selective areas where stipulated by the landowner/tenant or agency requirements. Therefore, the total acreage where topsoil will be stockpiled and preserved is unknown.

Where the applicant utilizes single trenching the topsoil will be mixed with the subsoil. The contamination of the topsoil with subsoils will occur on a maximum of 890 acres. This mixing process will alter the physical and chemical properties of the soil profile.

Mixing and burying the topsoil with the relatively infertile subsoil will prevent full restoration of the soil's productive potential until:

1) A new micro-organism community is established and becomes functional;

2) The physical and chemical properties of the material left on the soil surface are rehabilitated to the point where they are equal to the topsoil which was destroyed.

The severity of this impact on crops or native vegetation will depend to a large degree on the nature of subsoil material left on the surface. Plant reestablishment and growth will be inhibited on the acreage where single trenching results in contamination of the topsoil with generally infertile, adverse subsoils.

Compaction of soils, caused by heavy equipment traveling over the soil, will cause a loss of soil productivity and also reduce water infiltration within the pipeline right-of-way. Soil compaction will occur on a maximum of 11,000 acres.

Exposure to Wind and Water Erosion

Construction of the proposed pipeline will cause impacts upon the natural inherent productivity and physical qualities of the soil. The construction process will result in soil disturbance on a maximum right-of-way of 11,000 acres, however, soil disturbance will be concentrated primarily on 7,790 acres. This disturbance alters the soil's structural and chemical characteristics, microbiological activity, and soil-climate relationships which have been established over a long period of time.

Increased susceptibility to soil erosion by wind and water will occur on a maximum acreage of 11,000 acres as a result of soil disturbance by construction activities.

The extent and location of offsite facilities impacts cannot be identified until final design is submitted by the Applicant.

Tables 3.1.4.4-1, 2, 3, and 4 list soil series that will create special impact problems along the proposed route. The quantity of each series crossed is not known. Maps of soil associations in which the series occur and more detailed soil series descriptions are contained in Section 2.1.4.4.

The most severe erosion impacts caused by construction activity will occur on the soils situated along the proposed route between Spokane, Washington, and the Cascade Mountains in Oregon. This segment of the route contains most of the soils that have a high susceptibility to wind and water erosion if vegetation is removed. The expected soil loss from the 4,800 acres of soils situated in this segment is nearly 24,000 tons/year. Revegetation will be extremely difficult on these sandy, low productive soils.

Figure 3.1.4.4-1 illustrates the location of the more dominant soil limitation factors which may be encountered by the proposed pipeline. Every soil within each designated segment may not possess the identified soil limiting factor. Therefore, the following quantifications are estimates only.

Approximately 615 miles or 7,380 acres within the proposed 917 miles are susceptible to moderate to severe soil erosion resulting in an average soil loss of 115,000 tons/year.

The above soil losses represent average annual soil losses under existing conditions. The actual amount of soil loss which will be incurred following pipeline construction will be dependent on weather conditions and the conservation measures applied by the Applicant.

Wind erosion losses will cause local air pollution during and after construction until adequate vegetation cover is reestablished.

Approximately 485 miles or 5,820 acres of soil contain acidic concentrations that are corrosive to untreated steel. Approximately 252 miles or 3,024 acres of soils contain a moderate to high shrink-swell potential.

Cuts and fills cause soil structural changes which may result in mass movement and slides. Approximately 159 miles or 1,908 acres of soil contain a moderate to severe mass-movement potential. These actions add to soil loss, sedimentation, and decrease in water quality. Any increase in surface disturbance and compaction by off-road vehicle use could cause serious impacts on soil productivity and increase soil loss.

Disruption of Agricultural Activities

The proposed pipeline right-of-way involves approximately 5,100 acres of agricultural land. The disturbance on croplands due to pipeline construction will cause two major adverse impacts; the loss of crops during the constuction year, and the reduction of soil productivity for a number of years.

Table 3.1.4.4-1 Soil Limitation Interpretations, Selected Soil Series, Idaho

Assoc.	Dominant Series	Corrosivity1/	Shrink-Swell Potential 2/	Erosion Hazard3/	Mass Movement4/	Flooding5/ Frequency	Duration
A1	Huckleberry	Low	Low	High	Moderate to severe	None	--
C2	Selle	Moderate	Low	Moderate	None	None	--
C2	Schnoorson	High	Moderate	Slight	None	Frequent	Very long
C3	Kootenai	Low	Low	Moderate	None to moderate	None	--
C3	Molly	Low	Low	High	None to moderate	None	--
C4	Garrison	Moderate	Low	Slight	None	None	--

Table 3.1.4.4-2 Soil Limitation Interpretations, Selected Soil Series, Washington

Assoc.	Dominant Series	Corrosivity[1/]	Shrink-Swell Potential [2/]	Erosion Hazard[3/]	Mass Movement[4/]	Flooding[5/] Frequency	Duration
B1	Garrison	Moderate	Low	Slight	None	None	--
B1	Spokane	Low	Low	Moderate to high	None	None	--
B1	Bernhill	Low	Low	Slight to moderate	Moderate	None	--
B2	Naff	Low	Moderate	Moderate	Moderate	None	--
B2	Palouse	Moderate	Moderate	Moderate to high	Moderate	None	--
B2	Palouse	Low	Moderate	Moderate to high	Moderate	None	--
B5	Ritzville	High	Low	Moderate or high	Moderate	None	--
B6	Adkins	High	Low	Moderate or high	None	None	--
B6	Ellisforde	High	Low	Slight to moderate	None	None	--
B6	Adkins	High	Low	Moderate or high	None	None	--
B9	Athena	Moderate	Moderate	Moderate to high	None	None	--
B9	Walla Walla	High	Low	Moderate to high	Moderate	None	--
C9	Quincy	Moderate	Low	High	None	None	--
C9	Sagemore	High	Low	Slight	None	None	--
F3	Anders	Moderate	Low	Moderate to high	None	None	--
F3	Kuhl	Moderate	Low	Slight to high	None	None	--
F3	Magallon	Moderate	Low	Moderate	Moderate	None	--

Table 3.1.4.4-3 Soil Limitation Interpretations, Selected Soil Series, Oregon

Assoc.	Dominant Series	Corrosivity 1/	Shrink-Swell Potential 2/	Erosion Hazard	Mass Movement 4/	Flooding 5/	
						Frequency	Duration
D1	Stukel	Low	Low	Slight	Moderate	None	--
E1	Deschutes	Moderate	Moderate	Slight and moderate	None	None	--
E4	Madras	Moderate	Moderate	Slight	Moderate	None	--
F1	Walla Walla	High	Low	Moderate to high	Moderate	None	--
F1	Quincy	Moderate	Low	High	None	None	--
F1	Onyx	Low	Low	Slight	None	Occasional	Brief
J1	Steiger	Low	Low	Slight	None	None	--
J2	Lapine	Moderate	Low	Slight and moderate	None	None	--
K5	Crume	Low	Moderate	Slight	None	None	--
K5	Woodcock	Low	Low	Slight	Moderate	None	--
L1	Lickskillet	Low	Low	Moderate and severe	Severe	None	--
L2	Condon	Low	Moderate	Moderate	Moderate	None	--
L2	Bakeoven	Low	Low	Moderate	None	None	--
M1	Simas	High	High	Moderate and severe	Severe	None	--
M1	Lamonta	High	High	Slight	None	None	--
M1	Powder	High	Low	Slight	None	None	--
M1	Lorella	Low	Moderate	Slight	Moderate	None	--
N3	Ritzville	High	Low	Moderate to high	Moderate	None	--
N7	Gosney	Low	Low	Slight	None	None	--
S	Lickskillet	Low	Low	Moderate and severe	Severe	None	--

Table 3.1.4.4-4 Soil Limitation Interpretations, Selected Soil Series, California

Assoc.	Dominant Series	Corrosivity1/	Shrink-Swell Potential 2/	Erosion Hazard3/	Mass Movement4/	Flooding5/ Frequency	Duration
1	Fordney	Low	Low	Slight	None	None	--
2	Dotta	Low	Moderate	Slight	None	None	--
3	Lapine	Moderate	Low	Slight and moderate	None	None	--
4	Madeline	Moderate	High	Slight	Moderate	None	--
5	Tournquist	Moderate	Moderate	Slight	None	None	--
6	Crump	Moderate	Moderate	Slight	None	Ponded	Long
7	Cohasset	Moderate	Moderate	Slight to high	None	None	--
8	Toomes	Moderate	Low	Moderate to high	None	None	--
9	Tuscan	Moderate	High	Moderate	None	None	--
10	Toomes	Moderate	Low	Moderate to high	--	None	--
11	Columbia	Low	Low	Slight	--	Rare	--
12	Maywood	Moderate	Low	Slight	--	None	--
13	Corning	High	High	Slight to moderate	--	None	--
14	Newville	Moderate	High	Moderate or high	Moderate	None	--
15	Cortina	Low	Low	Slight	None	Common	--
16	Arbuckle	Low	Moderate	Slight	None	None	--
17	Hillgate	High	High	Slight	None	None	--
18	Myers	High	High	Slight or moderate	None	None	--
19	Willows	High	High	Slight	None	Rare	--
20	Sehorn	Moderate	High	Slight to high	Moderate	None	--
21	Positas	High	High	Slight	Moderate	None	--
22	Sacramento	High	High	Slight	None	Common	Brief
23	Yolo	Moderate	Moderate	Slight	None	None	--
24	Yolo	Moderate	Moderate	Slight	None	None	--
25	Corning	High	High	Slight to moderate	None	None	--
26	Sehorn	Moderate	High	Slight to high	Moderate	None	--
27	Rincon	High	High	Slight	None	None	--
28	Tierra	High	High	Slight	Moderate	None	--
29	Altamont	High	High	Slight	Severe	None	--
30	Rindge	High	Low	Slight	None	Common	Very long

1/ Corrosivity - of untreated steel. A rating of high means that untreated steel pipe buried in moist or wet soil has a high probability of damage. A high rating commonly indicates total soil acidity is $>$12m.e./100g soil, resistivity at field capacity is $<$ 2000 ohms/cm, or conductivity is $\geq$ 0.4 mmhos/cm at 25°C. "Low" is mostly moderately coarse and coarse, slightly acid to neutral soils. "Moderate" is: 1) sandy and sandy skeletal, mildly alkaline and medium acid soils; 2) coarse-loamy, coarse-silty and neutral to slightly acid soils; 3) sandy or sandy-skeletal, and neutral and slightly acid soils. "High" is all other soils.

2/ Shrink swell - a "high" potential indicates a hazard to maintenance of structures built in, on, or with materials having this rating. The Coefficient of Linear Extensivility (COLE) is $>$.06. Examples are soils in fine or very fine montmorillonitic families. Soils in fine-silty, fine-loamy, and clayey-skeletal families are rated as "moderate". All other textural families are rated as "low".

3/ Erosion Hazard - Slight, moderate, or high hazard where soil is bare.

4/ Mass Movement - <u>None</u>: No reasonable potential of mass movement in immediate landscape. Areas presently not in motion. Examples, flood plains and other areas with slopes less than about 5%.

<u>Moderate</u>: Possible mass movement with unusual combinations of climatic and/or crustal movements. Examples, piedmonts, pediments, footslopes, talus slopes, colluvial - alluvial interfaces in areas with slopes about 5 to 30%.

<u>Severe</u>: Probable mass movement with unusual combinations of climatic and/or crustal movements. Examples, mountains, fault scarps, rock slides, talus slopes in areas with slopes over about 30%. Underlying bedrock is commonly schist, marine shale, serpentine, severely weathered granite.

5/

Flooding - Frequency: None - No reasonable possibility of flooding
Rare - Flooding unlikely but possible under abnormal conditions
Common - Flooding likely under normal conditions
Occasional - Less often than once in two years
Frequent - More often than once in two years

Duration: (Note only if frequency is common or more) Very brief - Less than 2 days
Long - 7 to 30 days
Brief - 2 to 7 days
Very long - 30 days

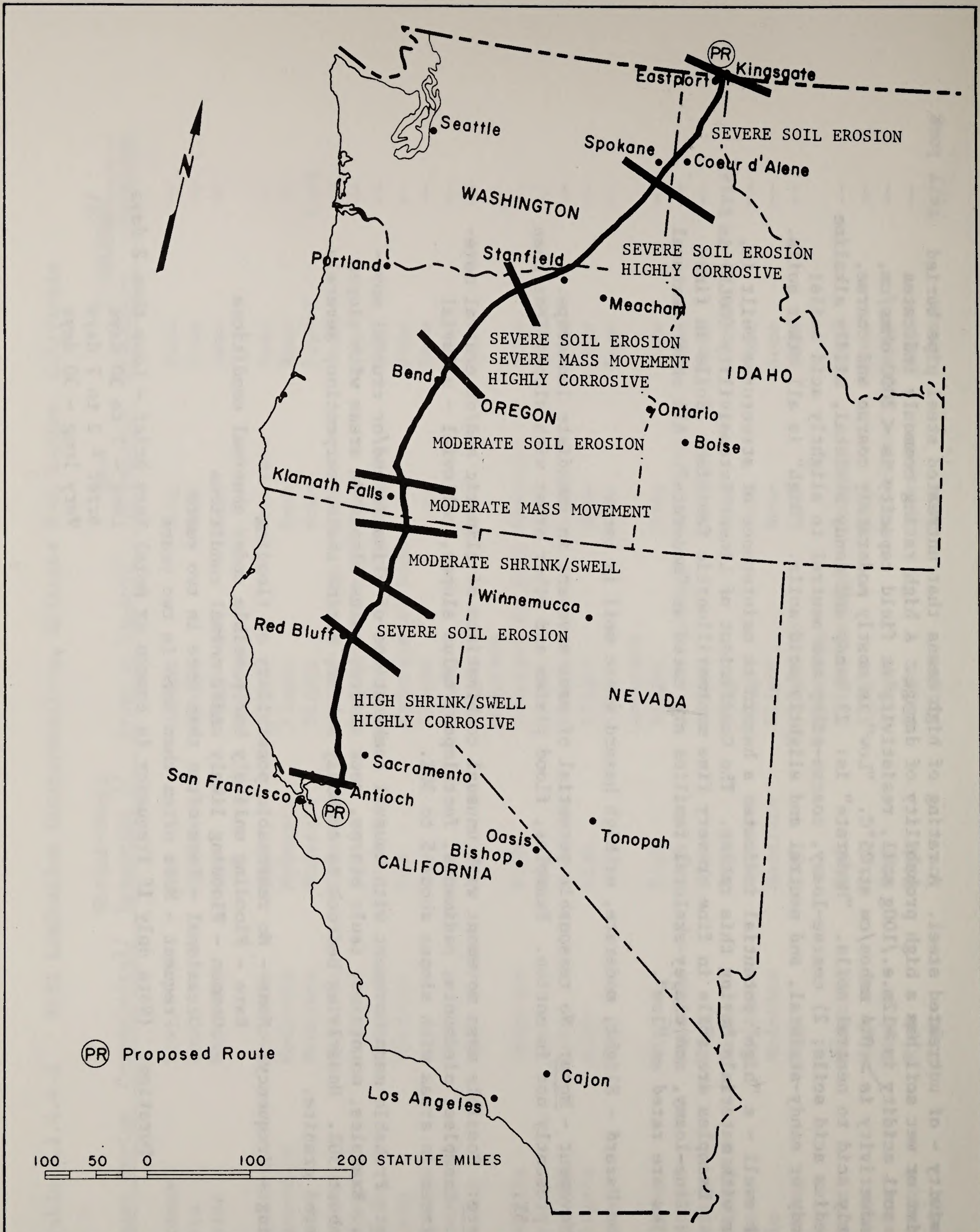

Figure 3.1.4.4-1 Dominant soil limitations

It is difficult to assess the crop reductions that will occur after construction operations are completed. As previously indicated, areas where topsoil replacement will take place have not been specifically identified. Also the degree of soil compaction will depend on the type of soil and moisture content at the time of construction.

On areas where topsoil is replaced and soil compaction is not severe, crop production should be nearly normal the year following construction. Where topsoil is not replaced and soil compaction is severe, continuing crop reduction will depend upon the kinds of subsoil or substrate material left on the surface and the intensity of rehabilitation.

Even where subsoils have good textural qualities, they will lack fertility.

In addition to crop reductions, the pipeline construction activities will create a variety of inconveniences for the farmer. Movement of farm machinery and tillage and harvesting operations will be complicated by the trenching through established fields. Compaction or subsidence of fill areas along the trench and the exposure of cobbles or gravel on the surface will all contribute to more difficult farming operations.

Irrigated lands that will be crossed by the proposed pipeline are discussed in section 2.1.4.11. Disruption of the irrigation delivery system during the irrigation season will affect crop production on the entire area served by an irrigation system. Pipeline construction may necessitate releveling of irrigated land, however, due to the difficulty of compacting the fill material to correspond with the adjacent undisturbed soil, several releveling efforts may be needed as the fill continues to settle.

As on non-irrigated cropland, construction activities will take land out of production for one growing season and reduce production for several years if topsoils are not replaced. Special care will be required to restore existing soil density and slope conditions so as not to interfere with the irrigation system.

Grazing land will be out of production during the construction year and will produce at a reduced rate for several years until new vegetation can be established. Construction activities will adversely affect grazing patterns since livestock will probably be reluctant to approach or cross the construction area. There will be the potential danger of animals falling into the open trench during construction.

Future abandonment impacts of the proposed pipeline could be negligible or significant depending upon procedures adopted. If capped and left in place, impacts upon the soil would be negligible. If the line were salvaged, the soils would again be disrupted causing recurrence of the above described soil impacts. In addition, backfill of the trench would require the removal of soil from borrow sites, and would further add to environmental modification with attendant impacts as described throughout this section.

3.1.4.5 Water Resources

Environmental Impact on Surface Water

The surface-water impacts are discussed in the following general order: (1) channel erosion; (2) sedimentation, including turbidity and suspended-sediment; (3) water quality; and (4) aquatic biology.

Channel erosion as a result of excavation, diversion, or constriction of the natural stream channel will be an impact during pipeline construction. The natural cohesion and vegetative cover of banks will be disturbed by trenching and other construction activities at the crossing sites. Increased erosion will persist until bank slopes are stabilized or vegetation is reestablished. The recovery period would be 1 year or more. The impact would occur at the 26 crossings of 18 major streams and at all minor stream crossings. The volume of material that would be eroded is unknown.

Discharges of hydrostatic test water could cause substantial channel erosion, if released to dry channels or those with small surface flows. Discharges of test water, if made from sections of the proposed pipeline no more than 20 miles in length (many test sections will be shorter), would be as much as 950,000 cubic feet for each release. Even if released in ephemeral streambeds with high infiltration capacity, a volume of this magnitude will modify the channel configuration, induce local streambed erosion, or gullying, and create or augment surface flow for at least several miles. If the water is reused and released only in major rivers, the impact would be negligible.

Where the proposed pipeline is placed across a major stream by the flotation method, a small amount of streambed fill could occur downstream for distances less than 500 feet. If the excavation is allowed to fill by natural bedload transport, scour could occur for a short distance (less than 200 feet) upstream. These impacts on streambed elevation would be temporary. Secondary impacts of these and other activities are addressed in the sections dealing with fisheries and vegetation.

Structures, such as supports and ramps built either as permanent structures or temporary components of a crossing will have variable, unpredictable erosive effects. They will also cause local scour at the site of channel constriction. Diversion of flow will increase erosion downstream and change the loci of points of erosion and deposition. The effects will be most noticeable just downstream from the structures and will die out gradually over a longer but unpredictable distance. It is unlikely that the impact of channel erosion will be serious considering the apparent natural conditions now evident in the crossing of the existing pipeline. Areas not subject to natural erosion in the flood plains of the stream will be eroded as a result of such structures.

Where the proposed pipeline is laid across several major streams, the most important single impact on surface water will be increases in suspended-sediment concentration and turbidity during construction. Pulses of fine sediment will be introduced into the channel during excavation. Effects on the biota are discussed below and in the section on fisheries (3.1.4.7) and vegetation (3.1.4.6). The release of water used for hydrostatic testing and construction activities will trigger increases in turbidity in the crossing of Lake Britton, a reservoir on the Pit River. However, much of the suspended matter may be redeposited in a short time because of the smaller amount of current-induced turbulence in the lake compared to a river. Flow releases from Lake Britton could be affected but the degree of impact will depend on the schedule of reservoir releases at the time of construction.

Similar but more localized effects will occur in sediment size classes coarser than silt. Most bed material at the crossing sites will have a modal class in the sand and pebble-gravel ranges. These coarser grades of sediment disturbed by construction will move insignificant distances as bedload. This will cause small amounts of temporary fill immediately

downstream from the crossing sites and small amounts of temporary scour upstream to accumulate.

The potential for impact by increased levels of suspended-sediment concentration and turbidity at major stream crossings is shown in Figure 3.1.4.5-1. These impacts will be temporary effects caused by pipeline construction at each crossing site.

The scale of impacts is defined as follows:

LOW -- A low possibility of raising suspended-sediment concentrations or turbidity to either a level or for a duration that could cause significant detrimental effects--either aesthetic, biologic, or on water use.

MODERATE -- A moderate possibility as above.

HIGH -- A high possibility as above.

Many factors enter subjective determination of the probability of significant impact by suspended-sediment or turbidity. Among these are the size distribution of bed and bank material; the flow level; construction practices; type and hydraulic gradient of the channel; natural levels of suspended-sediment concentration and turbidity; and the stream biota. The data necessary to determine the precise effects can be obtained only from study of the effects of previous pipeline construction at these crossing sites. It is assumed, for the analysis, that construction would be timed so that it would not coincide with the major spawning or hatching periods of anadromous fish. In cases where this is not possible, the impact-possibility level would be high.

Although significance of impact does not directly correlate with absolute values of suspended-sediment concentration, the ranges of the expected increases in concentration associated with the impact-possibility levels above could be estimated. At crossing sites with a low possibility of significant impact, suspended-sediment concentrations may increase by a factor of 10 above those characteristic of periods of low to medium flow, and generally less than 2000 mg/l. Concentrations at sites with a moderate possibility of significant impact may increase as much as 50 times. High-impact levels would exceed those of moderate impact. It is reiterated that the absolute values of suspended-sediment concentration depend upon so many variables that these figures must be regarded as "order of magnitude" estimates.

The average active period of construction at minor streams will be about 2 weeks, and at the major streams about 6 weeks. These are shown in Figure 3.1.4.5-2. However, the overall construction time will range to a maximum of 1 month at minor streams and 3 months at major streams. Suspended-sediment concentrations and turbidity levels will be elevated for these periods and will gradually return to normal.

Other factors not related to the physical site conditions but which play a role in assessing the significance of impact include: (1) the installation of double security loops at some sites (Kootenai, Pend Oreille, and Snake Rivers); (2) the number of crossings of each stream (Moyie River--eight crossings); and (3) status as proposed or potential additions to the National Wild and Scenic Rivers System (Moyie, John Day, and Sacramento Rivers).

Impact assessment can place the particular effect in perspective, by comparing natural phenomena with man-caused actions. The proposed pipeline

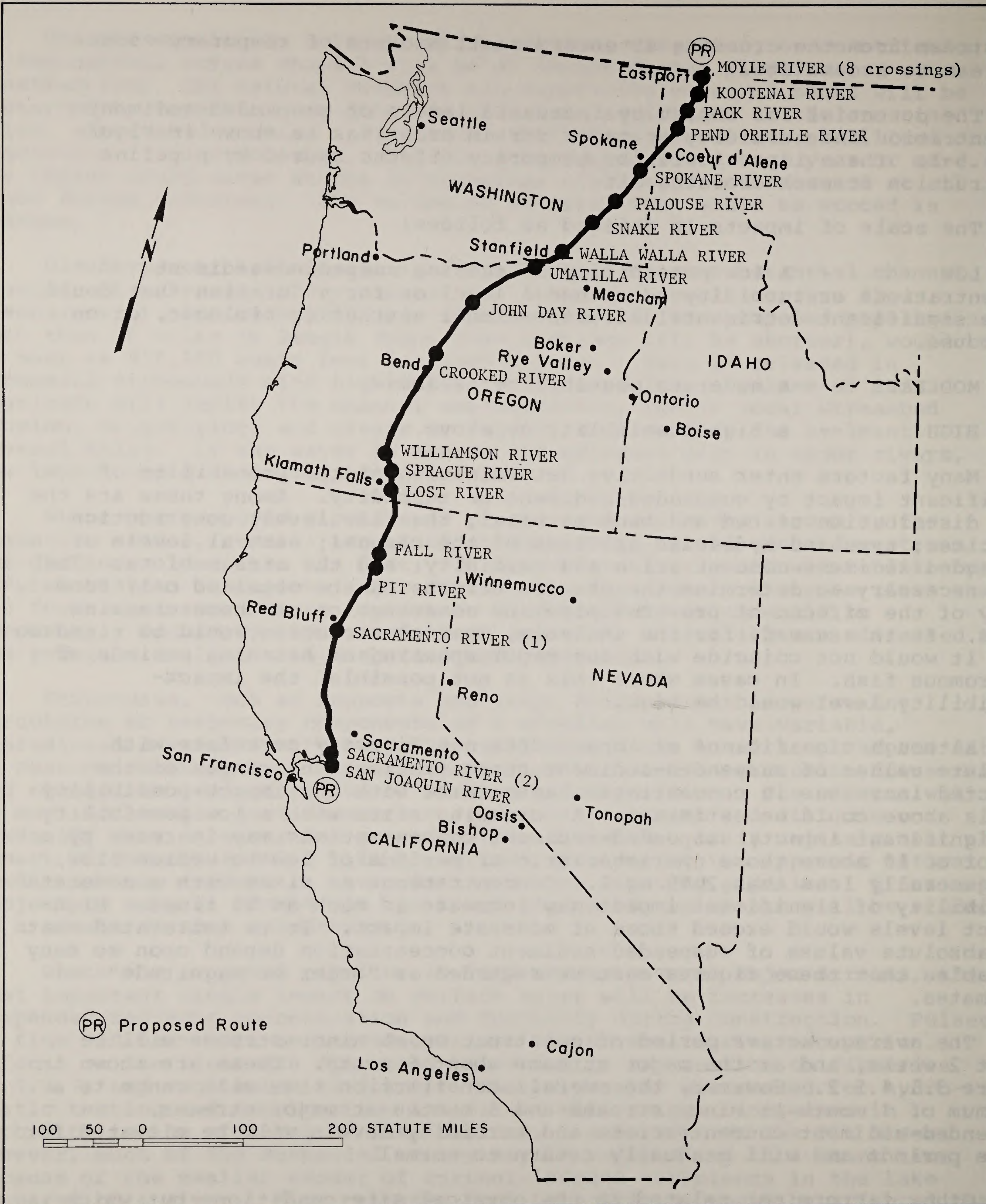

Figure 3.1.4.5-1 Major stream crossings where the pipeline has potential impact on channel erosion, sedimentation, and turbidity

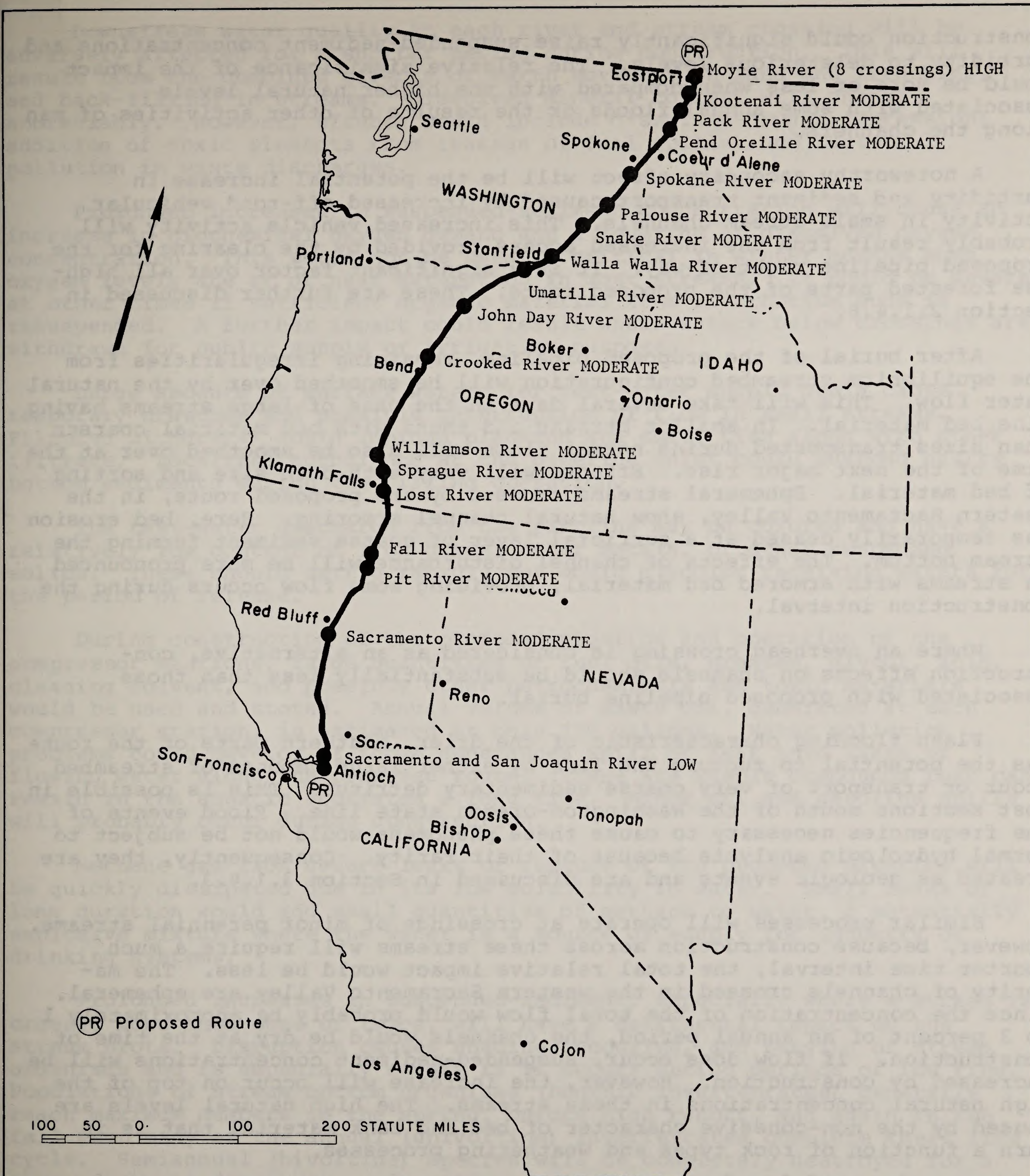

Figure 3.1.4.5-2 Anticipated impacts at major stream crossings

construction could significantly raise suspended-sediment concentrations and turbidity to deleterious levels. The relative significance of the impact could be more or less when compared with the higher natural levels associated with some annual floods or the results of other activities of man along the channels.

A noteworthy secondary effect will be the potential increase in turbidity and sediment transport caused by increased off-road vehicular activity in small stream channels. This increased vehicle activity will probably result from the increased access provided by the clearing for the proposed pipeline right-of-way. It is a significant factor over all high-use forested parts of the proposed route. These are further discussed in section 2.1.4.6.

After burial of the proposed pipeline, remaining irregularities from the equilibrium streambed configuration will be smoothed over by the natural water flow. This will take several days in the case of large streams having fine bed material. In smaller streams and those with bed material coarser than sizes transported during normal flows will also be smoothed over at the time of the next major rise. Effects will vary with both size and sorting of bed material. Ephemeral streams crossed by the proposed route, in the western Sacramento Valley, show natural channel armoring. Here, bed erosion has temporarily ceased at a surficial layer of coarse sediment forming the stream bottom. The effects of channel disturbance will be more pronounced in streams with armored bed material, providing some flow occurs during the construction interval.

Where an overhead crossing is considered as an alternative, construction effects on channels should be substantially less than those associated with proposed pipeline burial.

Flash flooding characteristic of the drier, southern parts of the route has the potential to rupture the line by either large amounts of streambed scour or transport of very coarse sedimentary detritus. This is possible in most sections south of the Washington-Oregon state line. Flood events of the frequencies necessary to cause these phenomena would not be subject to normal hydrologic analysis because of their rarity. Consequently, they are treated as geologic events and are discussed in Section 3.1.4.3.

Similar processes will operate at crossings of minor perennial streams. However, because construction across these streams will require a much shorter time interval, the total relative impact would be less. The majority of channels crossed in the western Sacramento Valley are ephemeral. Since the concentration of the total flow would probably be approximately 1 to 3 percent of an annual period, the channels would be dry at the time of construction. If flow does occur, suspended-sediment concentrations will be increased by construction. However, the increase will occur on top of the high natural concentrations in these streams. The high natural levels are caused by the non-cohesive character of bed and bank material that is in turn a function of rock types and weathering processes.

It is impossible to measure the precise effects of erosion and sediment contribution from the construction sites. However, the effect will be temporary.

Other impacts include a possible increase in surface-water temperature and consequent reduction in dissolved-oxygen content caused by the removal of shading vegetation. Smaller streams in the northern, forested sections of the proposed pipeline are especially susceptible to shading effects. This would be minimized in places where the angle between the proposed pipeline and the stream approaches 90 degrees.

Downstream water quality at each river and stream crossing will be adversely affected for a shorter period during construction. This will result from the combined effects of earth movement on land and trenching, and back-filling in streams. Dissolved mineral content will change appreciably. However, effects could include dissolved-oxygen depression; addition of toxic elements from leakage of fuel spills, and bacterial pollution in waste discharges.

Prolonged increases in suspended-sediment concentration will cause an increase in biochemical oxygen demand and a lowering of dissolved oxygen concentration. This would not be usually critical in winter months when oxygen levels are at or near saturation in most streams. It could be severe at other times if sufficient organic material from riverbottom muds is resuspended. A further impact could result where waters below crossings are withdrawn for public supply or irrigation purposes.

Large amounts of surface waters for test-water supply could cause temporary drawdown and possible interruption of flow in small streams. Filtered withdrawal could impinge plankton and small fish along with other filtrate. Localized turbulence at the pipeline inlet could suspend nearby bottom sediments during the filling operation.

The test-water discharge from the pipeline may be colored and have a relatively low content of iron oxide, other metals, or other suspended solids. These should settle rapidly but would discolor receiving waters for the period of release.

During construction of the proposed pipeline and operation of the compressor stations, large quantities of fuel oils, greases, glycol, acid, cleaning solvent, and possibly other petrochemicals and toxic materials would be used and stored. Annual volume of waste oil, generated at each compressor station, is estimated at only 150 gallons. Water pollution problems could develop if those substances spill or leak into lakes or flowing water along the proposed route. These are stable compounds that can remain in the aquatic ecosystem a long time. Minor oil and gasoline spills will probably occur during construction.

Methane gas from severe leaks or rupture of the proposed pipeline will be quickly dissipated due to its low solubility in water. Small leaks of long duration would add small quantities of methane to water, a potentially explosive mixture where the water is a source of supply for industry or drinking systems.

Prolonged increases in suspended-sediment, especially where a stream is crossed more than once or twice, will have a detrimental impact on the stream biota. Disruption causes shading, scouring, and burying of stream organisms and is especially severe if it occurs during periods of low flow. Populations of stream-bottom organisms (benthic invertebrates) generally reach maximum numbers in the spring, before high runoff, and again in the fall when many of the annual (univoltine) invertebrates complete their life cycle. Semiannual (bivoltine) species will be completely destroyed for a short distance downstream and would have to be repopulated from other parts of the stream.

Primary and secondary impacts on both surface-water and groundwater supplies and quality will result from the addition of construction workers to local populations. Based on the Applicant's estimates, 10 construction spreads would work concurrently over the 917 miles for a 12-month period. Using 100 gallons per day per man as a basis for water consumption, daily sources of 225,000 gallons, about 40,500,000 gallons for a 6-month period, would be required. Most of this would be returned in a polluted form via

body wastes to surface and ground water. This will have a temporary adverse effect on the sanitation facilities of local communities in which the construction workers are housed.

If the proposed pipeline were abandoned, capped, and left in the ground, there would be no added impacts on water quality. If the proposed pipeline were salvaged, impacts would be similar but less profound than those previously discussed in this section.

Environmental Impact on Ground Water

Along nearly all of the proposed route from near Eastport, Idaho, to Antioch, California, the pipeline will be buried in the soils zone of aeration. This zone is substantially above the water table. Thus, virtually no immediate interaction or major impact would be anticipated between ground-water bodies and the proposed pipeline, either during construction or operation. In principle, cutting and backfilling the proposed pipeline trench could modify infiltration capacity at the land surface. Water discharged from hydrostatic tests of the proposed pipeline could locally infiltrate the land surface and eventually percolate to the water table. However, aggregate effect on recharge to an entire aquifer system probably would be too small to be noticed. When these effects occur, they seem to be more likely advantageous, than by increasing rather than diminishing infiltration.

In principle, the proposed pipeline should be appraised as a potential source of ground-water pollution by downward percolation. Such a potential seems virtually to be limited to the compressor-station sites. In the event of a ruptured pipeline elsewhere, released gas would vent upward rather than infiltrate downward into the soil. At the compressor stations, only a small source of hazard seems likely. Specifically, spilled lubricant or indiscriminately disposed waste can cause such hazards.

Noteworthy interactions can be anticipated at river crossings and across wetlands or other areas where the proposed pipeline trench would reach to and below the water table. At a river crossing, the proposed pipeline trench may cut into any alluvial valley train and its contained underflow. Some such trains are sources of usable ground-water.

The crossing of the Spokane River in eastern Washington could be the most vulnerable of all the crossings along the proposed route. This is due to its extraordinarily large valley underflow.

Wetlands and other areas of shallow ground-water ordinarily do not afford usable water supplies. Their effects are chiefly that: (1) during construction, the proposed pipeline trench would need to be dewatered; and (2) operating of the proposed pipeline could require protection against corrosion.

If the proposed pipeline crosses an area that could subside, due to clay compaction as large-scale pumping reduces head within the ground-water system, the pipeline could rupture. Such a rupture probably would have only minor effects on the ground-water reservoir.

Because of the relation between streams and the ground-water reservoir, prolonged reductions in streamflow volume or impairment of water quality would ultimately have a parallel effect on the ground-water reservoir. Therefore, in evaluating the impact on ground-water reservoir, effects on surface waters should be considered.

3.1.4.6 Vegetation

Nature and Extent of Direct and Indirect Construction Impacts on Aquatic and Terrestrial Vegetation

A 917 mile long right-of-way (approximately 11,000 acres) will be cleared of vegetation to accommodate construction of the proposed 42-inch natural gas pipeline from Kingsgate, B.C., to Antioch, California. A more detailed description of total land requirements are shown in Table 1.1.4.4-1. The proposed pipeline will be built parallel and adjacent to the Applicant's existing pipeline, except for a 21.4-mile segment (approximately 240 acres) across the John Day River in north-central Oregon. Approximately 426 miles (5,100 acres) of productive agricultural land, 274 miles (3,290 acres) of land designated as conservation land, and approximately 208 miles (2,500 acres) of timber land would be cleared. Conservation lands are those areas that are significant for watershed, recreation, grazing, and a broad array of similar public land uses.

According to the Applicants, site preparation and construction activities will involve à maximum of 11,000 acres, of which 9,500 acres are private lands. Except for the John Day River crossing, most construction activities will occur on 70 feet of the Applicant's existing 100-foot wide right-of-way across private lands. Consequently, surface disturbance will be reduced on private lands from 9,500 to approximately 7,000 acres for pipeline construction. Over 6,500 of the 7,000 acres were previously disturbed during construction of the existing pipeline. Based on the application for a 25-foot PGT and 40-foot PG&E temporary working area across Federal lands, total temporary work area acreage involved is approximately 550 acres. For the most part these 550 acres were undisturbed during construction of the existing pipeline.

A new permanent right-of-way 53.5 feet wide across the Federal lands and 100 feet wide across private lands for the John Day River crossing requires 240 acres. Except for the John Day area there is an overlap of the existing Federal right-of-way. The total amount of new permanent right-of-way will be 470 acres across Federal lands and 220 acres across private lands. Most of this Federal land was disturbed during construction of the existing pipeline. Consequently, constructing the new parallel pipeline will involve disturbing about 1,150 acres previously not disturbed in constructing the existing line.

Additional rights-of-way may be acquired from private landowners to enable construction of a second pipeline in the existing right-of-way and for support needs for construction operations, such as equipment storage.

Aquatic Vegetation

The proposed pipeline will involve 26 river crossings on 19 rivers, as described in Section 2.1.4.11 and river crossings table in Section 1.1.4.2. The complete removal of about 43 acres of aquatic vegetation within the right-of-way will occur. Excavation of the proposed pipeline trench across perennial waterways will cause downstream sedimentation. Increased turbidity from suspended solids reduces the depth of light penetration into watercourses. This reduces the productivity of the system, and ultimately reduces aquatic species food supply. This is an important consequence in lakes, but is of less importance in streams since much of the food available to stream fish originates outside the stream system or upstream from the disturbed area.

The existing right-of-way skirts the small marshes located between Naples, Idaho (M.P. 33), and the Pend Oreille River (M.P. 70); and in the Liberty Lake-Saltese Flats area (M.P. 110 to 115) in Washington. The proposed pipeline will pass near but not across these wetlands. Floating and partially or wholly submerged aquatic plants such as yellow pond lily, water milfoil, sedges, rushes, and cattails are the major vegetative species in these wetlands. In the event these wetlands are affected by soil erosion and sedimentation the adverse impact on aquatic plants would be temporary since natural reestablishment of these plants is relatively rapid.

Riparian plant associations destroyed by construction activities will also revegetate rapidly if the topsoil is replaced. However, tree species such as cottonwood, alder, hawthorne, and aspen will require many years to become reestablished, either through natural regeneration or by actual seeding and planting by the Applicant.

Terrestrial Vegetation

Complete removal of terrestrial vegetation will result from pipeline construction on a maximum of 11,000 acres. These impacts will be evident for varied periods of time, depending upon the vegetative type affected.

Approximately 2,500 acres of forest lands will be permanently removed from timber production of which 400 new acres will be removed by construction of the pipeline. Approximately 5,100 acres of various agricultural lands would be disturbed for at least one growing season. At least 3,000 acres of natural grasslands, woodland-bushland, and desert areas would be denuded.

Secondary impacts of the removal or disturbance of the vegetative cover in the 11,000 acres of existing and proposed right-of-way area will result in: (1) the immediate adverse visual change due to the barren appearance of the right-of-way; (2) a change in the amount and kind of vegetative cover available for soil protection, agricultural production, and wildlife habitat; and (3) long-term changes in certain plant communities within the right-of-way clearing limits.

A major immediate impact caused by construction will be the visual effect resulting from removal and/or modification of the vegetative cover along the length of the right-of-way. The duration of this impact will range from one growing season to the life of the project depending upon the existing vegetative community affected.

Clearing the vegetation will eliminate primary biological productivity and the annual crop of plant material that forms the base of terrestrial food chains. Therefore, the food available to small colonies of herbivorous animals, such as smaller rodents, will be decreased for at least one growing season.

In the grassland plant formation, vegetative growth can be fairly rapid, depending on the conservation measures applied by the Applicant. However, shrubs will take longer to reestablish and grow to a size which would make the pipeline right-of-way less noticeable.

In the cold desert, big sagebrush and other shrubs codominate with grass and will take many years to fully recover due to the slower establishment and growth rate of these shrub species.

Plant communities are well-established in the desert. To achieve natural conditions, reestablishment of vegetation in disturbed areas of the desert would be extremely slow and difficult.

The invasion of weed species will occur on the right-of-way and spread to nearby areas. This would pose potential problems, especially in the case of the invasion of noxious weeds and species that are extremely competitive with native vegetation. A rapid and successful invasion of undesirable annual brome grasses could prevent the reestablishment of native grasses, which are valuable as a food source to livestock and wildlife. Annual bromes inhibit the regrowth of shrubs, which are valuable as browse and cover. Plants belonging to the goosefoot, mustard, and sunflower families comprise a large percentage of weed species which would probably establish themselves on the cleared pipeline route.

Where the right-of-way passes across agricultural lands, a much higher potential for invasion by weeds exists than in more remote areas. However, natural seed dispersion and transport mechanisms render any area susceptible to invasion by undesirable species.

Normal operation and maintenance of the proposed pipeline would have no significant impact on aquatic vegetaticn or terrestrial vegetation adjacent or within the right-of-way nor will these activities normally affect stream courses or water impoundments. Observation of the existing 36-inch pipeline indicates that there is a loss of productivity of cropland on the right-of-way.

Existing roads will be used for operation and maintenance of the existing parallel 36-inch pipeline as well as the proposed pipeline. Therefore, no new adverse impacts are expected. No new roads will be needed except for the servicing of the new 21-mile segment across the John Day River Canyon in north central Oregon.

No new compressor stations, gauging stations, or other ancillary facilities will be constructed or used if the proposed pipeline is constructed. Additional appurtenances at existing locations would require additional clearing of several acres. Although gravel requirements have not been identified, it is recognized that some additional disturbance will occur from borrow areas for proposed pipeline bedding and station expansion.

Effects of Gas Leaks on Vegetation

Adverse effects of the operation of the proposed pipeline would be caused by pipeline failure resulting in massive gas releases with the potential for wildfire. For small leaks, the gas would be quickly warmed by the ground and ambient air, so that no gas would collect at the surface. For larger leaks and pipeline rupture, there could be a toxic volume of cold gas near the proposed pipeline. Small leaks can be detected during the growing season, as natural gas kills vegetation in the immediate vicinity.

Persistent damage would not be expected if the leakage was detected and the necessary repairs made quickly. Rapid detection would be necessary to prevent the possibility of persistent damage to the environment.

3.1.4.7 Wildlife

Nature and Extent of Direct and Indirect Construction Impacts on Fish and Wildlife

Construction actions which will create adverse impacts on wildlife are:

- Stream flow restriction
- Noise
- Presence of construction workers
- Timing of construction (assuming that timing will not be perfect)
- Test water discharge
- Blasting
- Creation and use of borrow pits
- Trenching
- Equipment storage (pipes, etc.)
- Clearing
- Burning
- Grading
- Stockpiling of excavated material
- Removal of oxygen in the water
- Use of herbicides

The evaluation of project construction effects on fish and wildlife and their habitats was made by analyzing the above actions on the various categories of wildlife, taking into consideration impacts on cover, food, breeding, nesting, and in some categories, migration and winter range.

The six actions that appear to have the greatest potential adverse impacts are in descending order: clearing of the proposed route, timing of construction, blasting, trenching, use of herbicides, and stream flow restriction. All other actions pose only temporary minor adverse impacts to wildlife.

In considering adverse impacts to wildlife, the most critical impact will involve disruption of the habitat and life cycles of rare and endangered species. Wildlife which will experience a moderate amount of adverse impacts are big game animals, small game and fur-bearing mammals, upland game birds, birds of prey, reptiles, and amphibians. Those that would receive a low impact are waterfowl, other birds, and small nongame mammals.

Big Game Mammals

Pipeline construction activities will produce insignificant long-term adverse impacts on big game habitats. Clearing of the vegetation on the right-of-way will have an adverse impact on big game for a period of about 1 to 3 years. A large portion of the proposed pipeline will pass through deer winter range. Clearing for the construction of the proposed pipeline will destroy this habitat and cause loss of winter deer food and cover for approximately 2,000 deer. A later increase in the variety of wildlife food and bordering vegetation will partially restore winter foods. The long-term beneficial impact of construction through forests is the replacement of trees with big game browse plants.

About 137 linear miles of big game winter range will be cleared for the proposed pipeline. Assuming that clearing will consume a 100-foot swath of vegetation, this represents 1,660 acres of temporarily lost winter range. This habitat loss equals the forage requirement for about 2,000 deer (based

on a low population of 0.8 deer/10 acres on 800 acres of winter range and a high population of 1.6 deer/10 acres on 860 acres of winter range). Impact of this temporary reduction of big game habitat cannot be considered significant on the narrow, 917-mile long right-of-way.

If the clearing and construction occur while big game are on the winter range, the animals will move from this vital habitat. The length of time that the animals will remain away from the periphery of the cleared swath will depend on the big game species involved and the length of time that construction crews and equipment are in the area. Construction activities during a particularly cold winter will have a decidedly greater adverse impact on displaced animals than if construction occurred during a mild winter.

The pipeline will cross several known deer migration routes (Figure 3.1.4.7-1). The open trench, aboveground storage of the pipe, and the presence of construction crews and equipment will cause deer to divert from their usual migration routes. The open trench will increase the risk of entrapment and injury to wildlife.

Spring construction will tend to disrupt deer fawning, elk calving, or antelope kidding activities.

Construction through big game summer range probably will not have significant adverse effects on big game animals. Normally, the availability of summer food is not a limiting factor to big game movement.

Hibernating big game animals may be killed by the pipeline construction if their dens are dug up during the winter. The possibility of such occurrences is obviously remote.

Small Game and Fur-Bearing Mammals

Many mammals are carnivores that generally have large home ranges which extend over several habitat types. The loss of a small portion of the home range within the proposed pipeline probably will have a minimal impact on these species.

On the other hand, certain herbivores, such as rabbits, usually have small ranges. Where proposed pipeline construction passes through these territories, the impact of removal of food and habitat on the individuals will be critical. However, this impact on the species population will be temporary, because of the great reproductive potential of these herbivores. Most small mammals will readily return to the right-of-way after construction and resume their usual activities.

The population densities of small game animals in areas influenced by the proposed construction ranges from low to relatively abundant. Species with naturally low population densities, such as martens, wolverines, and fishers, will take up to several generations to recover because of their low reproductive rate. Rabbits, bobcats, coyotes, and other high population density species will quickly recover to preconstruction levels.

Small Nongame Mammals

Localized elimination of individual small mammals such as mice, ground squirrels, voles, shrews, and/or their habitats will occur along the proposed route. The impact on their populations will be temporary, because of the short reproductive time of most of these species and the subsequent

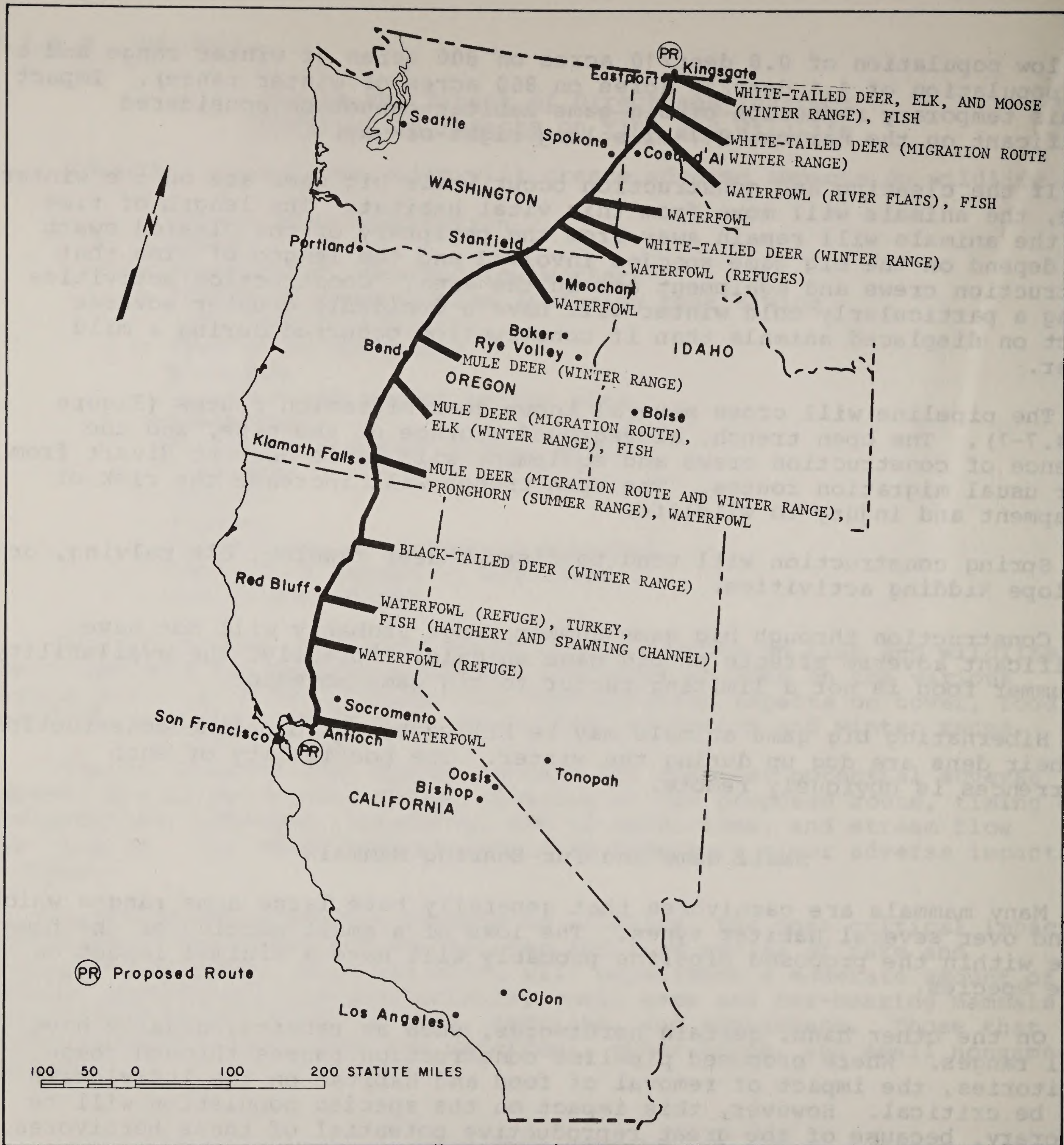

Figure 3.1.4.7-1 Critical wildlife areas along the proposed pipeline route

rapid reinvasion of the disturbed areas. There exist possibilities of shifts in species composition due to the change in vegetative habitat, especially in formerly forested areas of the proposed route which will revert to open grassland. In such cases, mice, rats, voles, and ground squirrels will be benefited, while tree squirrels and shrews will lose habitat. Construction of the proposed pipeline should have little effect on bats. Adverse impacts to small nongame mammal populations will be insignificant.

Upland Game Birds

Until right-of-way revegetation occurs, loss of habitat and food will affect game birds such as grouse, pheasant, partridge, and quail. The impact will not likely cause more than a 5- to 10-percent decrease in population within a 1/2-mile wide strip on either side of the proposed route. The decrease will be temporary and not significant.

The destruction of small watering areas such as springs and seeps will have serious impact on local bird populations because these sites are often the limiting factor in a particular locale. Construction in the vicinity of the Sacramento River crossing near Red Bluff (M.P. 755.3) will disturb wild turkey and cause a 1- to 3-year loss of less than 2 acres of habitat within the disturbed area.

Waterfowl and Other Migratory Birds

Construction of the proposed pipeline will not affect a significant amount of habitat suitable for waterfowl and other migratory birds. Marshes, small lakes, reservoirs, and similar bodies of water will be avoided. There are no extensive resting or feeding areas for waterfowl at the pipeline crossings of the major rivers and numerous smaller streams and creeks.

Construction noises, dust, blasting, and other construction-related disruptions will have a negative effect on waterfowl, especially during nesting and rearing activities. Adverse effects to waterfowl would end after construction activities have ceased.

Birds of Prey (Raptors)

The loss of habitat will adversely affect birds of prey. However, these impacts generally will be temporary. First, the source of food, cover, and nest or den sites for resident small mammals, birds, reptiles, and amphibians will be eliminated or temporarily reduced. This will initially cause a reduction in the amount of food available to the birds of prey. However, small animals crossing the cleared space will be more readily observed by these birds, and will become more vulnerable. As the proposed route revegetates these effects will be minimized.

Second, there will be a short-term adverse impact on breeding and nesting, especially in forest areas. This impact may reach to 1 or more miles on either side of the proposed route. The magnitude of the impact will decrease as distance increases. In the case of red-tailed hawks, screech owls, or great horned owls, loss of a few birds from a large population will have a minimal and temporary impact. However, the loss of only a few birds of less common species such as golden or bald eagles will represent a significant reduction in the total population.

Overall, the effect of construction will be about neutral to common raptors and slightly deleterious to less common raptors.

Other Birds

The loss of habitat will have a slight, temporary adverse impact on songbirds and most other birds foraging in the proposed route. For most species, the area involved probably is only a small proportion of the total area in which they normally forage. The impact will be localized, temporary, and minimal in terms of the population of the general area. Overall pipeline construction probably will not reduce the population over 10 percent within a 1-mile strip straddling the proposed route. Population recovery will take from 1 to 3 years. After revegetation there will be a 5- to 10-percent increase in birds near the proposed route, except for cavity nesting species.

Reptiles and Amphibians

Most reptiles and amphibians are mobile and many will escape the path of construction equipment. A few probably will be killed or injured, particularly those which are hibernated or retreated to dens or nests. The impact will be temporary and minimal as other individuals will invade the region following revegetation.

The loss of habitat will have a moderate to severe impact on some species. Pools inhabited by frogs and salamanders will be altered and drained and entire populations lost. Stream crossing construction probably will affect water temperature for up to 2 months and flow reduction for only a few days. Where all the shrubs are removed in the arid areas, snakes and lizards will not readily reoccupy the area due to the lack of shelter from the sun. Until these and similar habitat requirements become reestablished, the populations on the cleared right-of-way will be reduced by as much as 50 percent.

Terrestrial Invertebrates

Except for moths, butterflies, and other groups of winged insects, most species of invertebrates in the proposed route will not escape clearing and will be destroyed. However, the impact on total populations of these species including the Tussock moth and mountain pine bark beetle is insignificant because most are widespread and numerically abundant, with high reproduction potential and short generation time.

Aquatic Animals

The greatest impact due to construction will be from downstream siltation and turbidity at and in the vicinity of stream crossings. Lesser impacts will be from stream blockage by either construction at stream crossings or blasting in streams, and hydrostatic testing.

The impact on anadromous fish cannot be accurately predicted. Only one annual spawning run has the potential of being affected by the construction at any particular crossing, but this would adversely affect the population for many years. The impact will be least during midsummer when fewer fish are migrating. Construction activities across most of the rivers will require a relatively short period of time. Normally these fish will be able to circumvent construction barriers because construction activity occurs in

a small proportion of the river cross section. Unrestrained construction activity could damage or destroy important spawning substrata and other vital habitat for 6 months to 3 years.

Shocks from blasting in or near streams will cause a loss of anadromous fish during the very sensitive first 3-week period of egg development. The effects of shock during later stages of egg development, hatching, and alevins prior to emergence from the gravel presently is being studied and is expected to be less than that to early egg stages.

At stream and river crossings where blasting is necessary, territorial fish, such as sunfish or trout, will be killed, injured, or stunned. Schooling fish, such as whitefish or suckers, probably will have already vacated the pool by the time blasting occurs.

Fish populations will suffer losses directly or indirectly if there is an increase in silt due to runoff from construction sites and a loss of vegetative cover. Juvenile or adult fish can tolerate heavy concentration of silt and will be able to move away from regions of high silt density. Nonmobile eggs and fry will be damaged. Even small amounts of fine material will be detrimental to spawning and fry survival. Sediment is less damaging to warmwater and/or rough fish adapted to living and spawning in turbid water.

Loss is estimated to be from about 1 to 10 percent in waters within 1 mile downstream from pipeline stream crossings. Fish will be somewhat more sensitive to silt during the spring to early summer spawning season. Fish nests which are continually silted will be abandoned. Finally, reproduction by the adult resident fish near the construction area will be adversely affected by a late spring or early summer construction.

The temporary gross physical disturbance and siltation of aquatic habitat from construction at river crossings probably will be the most adverse impact caused by laying the pipeline across rivers and streams. A heavy discharge of hydrostatic testing water in a small stream could cause downstream turbidity and siltation and destroy fish eggs or fry. If the source of supply for hydrostatic testing is from a stream at a low flow stage, serious disruptions of aquatic life will occur.

Streamside slash and other debris could block small streams and prevent or curtail fish movements and migrations.

The timing of the crossings of Battle Creek above the Coleman National Fish Hatchery near Anderson, California, and the Tehama-Colusa Spawning Canal near Red Bluff, California, are critical to the production of trout and several million salmonid fry.

Unique, Sensitive and/or Threatened Populations

Critical habitat for unique, sensitive, threatened, and/or endangered species along the proposed pipeline are shown in Figure 3.1.4.7-2.

Disturbance and disruption of riparian habitat at the Sacramento River crossing and tributaries from M.P. 730 to 770 will adversely affect the rare California yellow-billed cuckoo which nests in the riparian vegetation. The degree of the impact is unknown. Likewise, any adverse alteration of sloughs in the vicinity of the Sacramento and San Joaquin Rivers near Antioch may be detrimental to the giant garter snake which depends on this habitat for food and cover on Sherman Island. Three sloughs would be crossed, but the impact of the pipeline on these sloughs and the snake is

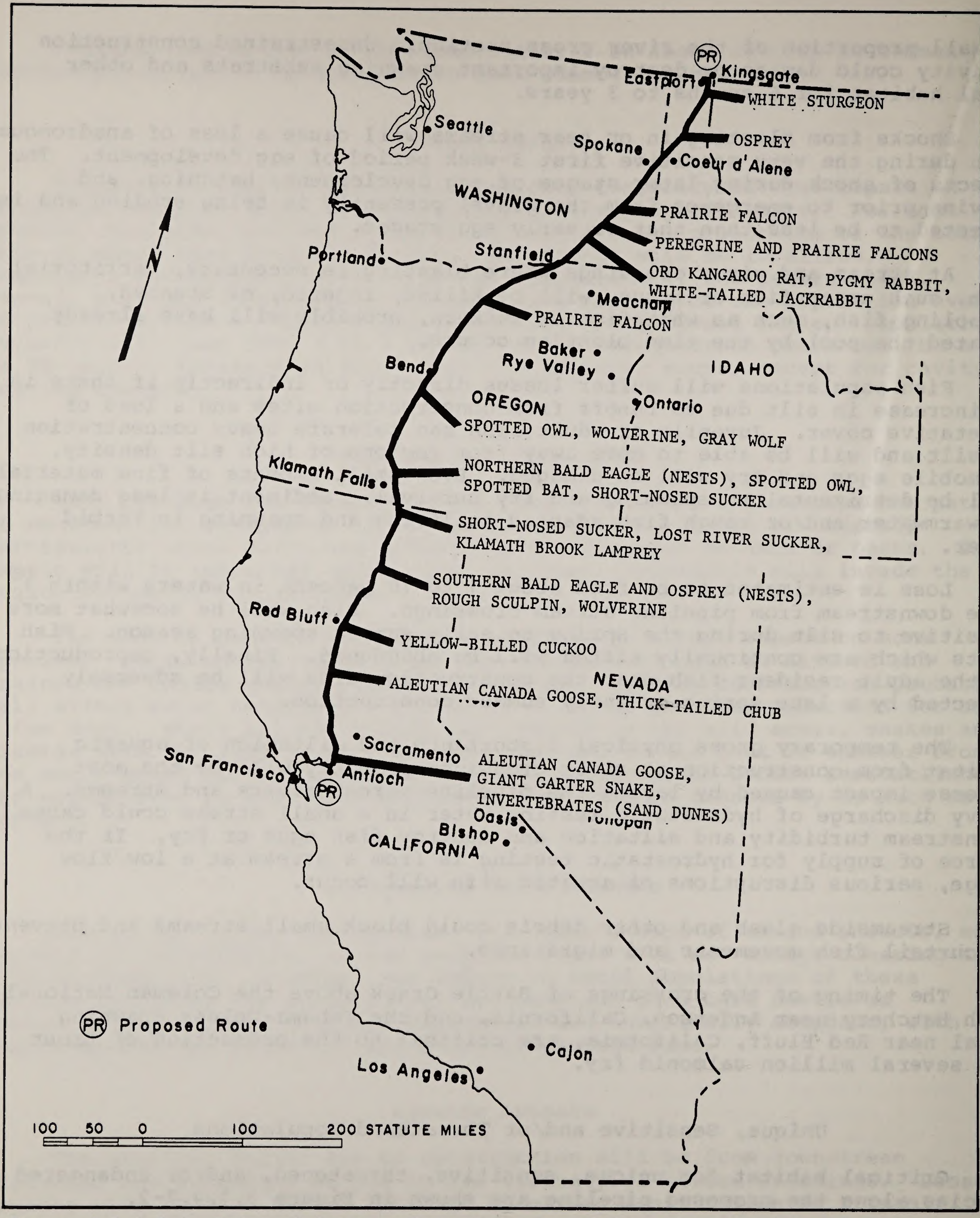

Figure 3.1.4.7-2 Critical habitat for unique, sensitive, threatened, and/or endangered species

unknown. If water levels remain unaffected by the construction, habitat probably will recover in the first year.

The rough sculpin will be adversely affected by sediments from the Fall River crossing. There will be a physical displacement of fish by silt filling interstitial spaces among the stream bottom rubble where these fish spend most of their time. The smothering effect of the silt will greatly reduce bottom invertebrates that either directly or indirectly furnish food for the rough sculpin. Effects will be primarily downstream from the Fall River crossing. The Fall River crossing is of greatest concern because sculpins are primarily stream dwellers. Habitat loss would be greatest during and for 2 to 3 months following construction. Complete habitat recovery could take 2 or 3 years.

Endangered Species

Endangered species are in delicate balance with the existing environment, and any change is apt to be detrimental.

Construction activities will be detrimental in areas where mountain lion occur, such as northern Idaho and heavily timbered sections of Oregon and northern California. Mountain lion avoid areas of human activity and often move into unfamiliar territory. Habitat destruction itself will have little effect on the animal.

The Northern Rocky Mountain wolf is so rare that its occurrence along the proposed route is not recorded. If the proposed route does cross the home range of individual animals, effects similar to those described for mountain lion will occur.

The spotted bat, like the Northern Rocky Mountain wolf, is so rare that it is uncertain that it occurs in the vicinity of the proposed route. Adverse impacts probably will not occur.

The Ord kangaroo rat has a very limited range, but the proposed pipeline probably will not adversely affect the animal. Unlike the other endangered species it is gradually extending its range.

Any alteration of the sagebrush type habitat will adversely affect the pygmy rabbit. The same is true of alteration of the transitional type habitat where the white-tailed jackrabbit occurs. Recovery of this habitat will be slow, possibly requiring from 3 to 10 or more years.

Peregrine falcons and eagles probably will abandon preferred nesting or feeding sites within a mile of construction because of noise and general disturbance. Because of critical nesting tolerances, the loss of nesting habitat will represent a further threat to these species. In addition to nesting disturbance, any water contamination which results in loss of food for raptors will be highly detrimental.

The spotted owl will be adversely affected wherever the proposed route crosses dense forests. The population loss cannot be predicted because of lack of information on present population size and range. It is highly improbable that any roosting trees of these owls will be disturbed during the construction of the pipeline.

The impact on the Aleutian Canada Goose and Tule white-fronted goose is unknown. Any unnecessary disturbance near the Colusa and Sacramento National Wildlife Refuges of California will have detrimental effects on

these species. Tule white-fronted geese are infrequent migrants and move easily to another wet area if disturbed.

The only remaining permanent populations of shortnose and Lost River suckers are found in Clear Lake Reservoir. The proposed pipeline will pass to the west, downstream from the reservoir and thus not directly affect the population.

The impacts on other species listed in Figure 2.1.4.7-1 are considered minor or nonexistent since they are generally remote from the existing pipeline or will move away from disturbances associated with construction of the proposed pipeline.

Other Minor Impacts on Terrestrial Animals

The following minor impacts are generally of a short-term nature. Smoke from onsite burning of trees, slash, and debris could disturb birds, particularly those nesting in the area. Some dust will be raised by construction activity but wind and rainfall will remove most of it.

Noise from machinery, people, and blasting, as well as the constant activity associated with construction, will disturb animals in the immediate area. This type of impact is of more concern to the rare and sensitive eagles, peregrine falcons, and prairie falcons. The more common species such as most owls and the redtailed hawk will quickly recover. Small birds, mammals, and invertebrates and other small organisms that have home ranges within the proposed route will be disturbed by the noise and activity. Similar animals in adjacent areas will suffer only minor impacts.

Nature and Extent of Direct and Indirect Operation and Maintenance Impacts on Fish and Wildlife

The operation and maintenance actions which create fish and wildlife impacts are:

- Use of access roads
- Increased public access
- Pipeline breaks
- Storage tank accidents
- Sewerage disposal
- Noise
- Erosion
- Sedimentation
- Surveillance and monitoring
- Pipeline repair work

The actions that appear to have the greatest potential impact in order of importance are: increased public access, erosion, pipeline repair, and storage tank accidents.

Because natural gas pipelines require only minimal maintenance, there will be limited impact during normal operation. A possible exception will be the detrimental effect on some big game and rare and endangered species resulting from increased human access and possible harassment.

There will not be an increase in the number of presently existing compressor and metering stations or maintenance bases. Four compressor stations (numbers 10, 12, 13, 14) will be enlarged. A slight increase in noise and activity will have a very limited impact on wildlife.

The other types of operating and maintenance activities are already being done on the existing pipeline and therefore there is no need to expand their intensity for the proposed parallel pipeline. Consequently, operation and maintenance will have little or no additional impact on fish and wildlife.

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3.1.4.8 Ecological Considerations

Sections 2.1.4.6 through 8 describe the natural vegetation, wildlife and ecosystems relationships which have already been altered by the Applicant's existing pipeline right-of-way.

The construction and maintenance of the proposed pipeline project will add a minimum amount of disruption of natural ecosystems where they exist and to varying degrees affect ecosystems already adapted to human influences as a result of the existing pipeline route.

As the topsoils are excavated for rights-of-way and the pipeline trench, the vegetation will be destroyed. With the disruption of the basic food chain elements, the ecosystems will change along the disturbed portion of the right-of-way. Even where topsoils are replaced and revegetation is successful, the reconstituted site will differ from that of the existing site prior to disturbance.

Since the proposed pipeline will involve only 1,150 acres of land through the major ecosystems, the adverse effects to total major ecosystems will be minor.

In the cultural ecosystems where man harvests the crops and makes supplementary energy inputs, man, the ultimate consumer, will be affected by

the decreased productivity of grazing and croplands. These ecosystem productivity losses have been described in previous sections.

Disturbances to the limited natural existing ecosystems along the pipeline route will create the most serious impacts, especially to the wildlife consumer members of the ecosystems. Adverse impacts will occur primarily during the construction phase of the project. Biotic communities will be adversely affected not only by the loss of habitat but also by the disturbance created by man's presence with his equipment.

The productivity of aquatic ecosystems will be temporarily lowered during and after construction in streams and rivers crossed by the proposed project. The reproduction of game, commercial and forage fish, and the reproduction and growing conditions for macroinvertebrates, would be adversely affected for probably one breeding and growing season. If proper measures to limit erosion and sediment from stream banks are used, the aquatic ecosystems impacted should essentially recover within 2 years.

The environmental impact will not affect any one extensive ecosystem in a particular segment of the route but will affect small scattered remnants of natural habitat areas along the proposed route which will be disrupted by construction activities.

The brushy gullies, the fringes of brush and trees along intermittent streams and drainage ditches, the strips of bottomland trees along the creeks and rivers, the scattered woodlots and windbreaks, and the uncultivated areas along fence rows and property lines are critical aspects of primarily cultured cropland ecosystems. These limited natural areas are basic to any remaining diversity of vegetation, wildlife habitat, and wildlife species within the cropland ecosystem as they form a refuge from which big game, furbearers, game birds, songbirds, hawks, and owls can venture out into the cultivated areas. The rodents and insects consumed are an important factor in cropland productivity. The destruction of segments of these limited habitats along the construction route could have significant adverse effects on the size and diversity of wildlife populations along the proposed route, on the diversity of plant species, and on human opportunities to use and enjoy these diverse populations. The trend has been toward pure cultured cropland ecosystems over extensive areas of the country and this additional loss will accelerate this trend.

3.1.4.9 Economic Factors

Employment

The social or economic impacts resulting from construction of the proposed pipeline will depend on the particular construction schedule followed. The estimated manpower requirement of 15,000 to 18,000 man-months is based on 10 spreads of 250 to 300 men each, working for 6 months. If construction is in one phase, spread over a year's time as proposed by the Applicants, then employment impacts will be minimal.

Due to the skill levels required for pipeline construction, it is estimated that less than 25 percent of the construction labor requirement will be locally obtainable. Since the majority of the work force is expected to be non-local, construction is not expected to measurably affect local unemployment statistics. The estimated five additional permanent compressor station maintenance personnel will have a negligible impact on employment.

Most of the 100 secondary employment positions will come from the local area. Some of this will be in the form of new positions, but most of this impact is expected to be in the form of increased use of the existing underemployed work force. Employment effects cannot be pinpointed at specific locations.

Population

Because of the fairly brief time span in which construction crews will be in any given area, construction of the proposed pipeline will have no long-term population impacts. Over any given 100-mile spread the maximum population change associated with pipeline construction will be between 300 and 500 persons. This impact will last for a period of no more than 6 months. Temporary residences of workers will be dispersed among several communities at any one time.

Housing and Community Services

The proposed project is not expected to have a measurable inflationary or housing impact on the supply of community services. A closer estimate than the 300 to 500 persons per spread is not possible because the decision of any individual family unit to move to the construction areas will depend upon several variables. Some of these are: number of children, age of children, availability of housing and other services, expected length of stay (which depends on the sequence of pipeline spread construction), time of year, and the degree of permanency of their previous residence.

The number of family units with children will affect the demands placed on community services (schools, health services facilities, parks, and recreation) and certain housing types (trailer courts and apartments) differently than will household units without children. Regardless of the final composition of family units, approximately 250 housing units of some type would be needed per spread.

The Oregon Plateau and Northern California Mountain Area probably are the most susceptible to impact on transient housing facilities because of the relatively small size of the communities. However, this will depend on the time of year that construction is done. If construction is done during the off-tourist season, ample facilities are available.

Pressure on living quarters will not be expected to strain capacity in the Idaho-Washington portion of the line because of populous centers of Coeur D'Alene and Spokane. The California valley portion also will not be expected to experience housing pressure.

Description of impacts on community services beyond the preceding analysis is not possible without knowledge of specific living locations and construction dates -- this information is not available. However, impacts on community services are not expected to be severe when one considers that the increased population density spread over the entire route is a maximum of only five persons per mile of pipeline constructed.

Principal Economic Activities

Since the contractors who will actually build each spread of the pipeline have not been selected, it is impossible to know just where this portion of the construction expenditures will flow and its ultimate economic impact. Bidders on construction of the pipeline likely will be firms with

some degree of experience in pipeline construction. There is no reason to expect that these will be mainly local companies. Also unknown at this time is the geographic pattern over which construction supplies and materials will be purchased. It is likely that supplies and materials will be purchased from a diverse area. The largest single expenditure will be for the 917 miles of large diameter, heavy wall pipe. The source of the pipe required is unknown. Hence, the locality of the socio-economic impact of a considerable amount of the expenditures for this pipeline cannot be specifically identified at this time and likely will not be known until actual construction decisions begin to be made.

It is unlikely that the increase in demands for goods and services resulting from this construction will induce increased capital investment by the local suppliers of these goods and services since it will be apparent that the demand will last only a few months -- until the construction crew moving at about 1 mile per day builds out of that supplier's service area. Some temporary increase in personnel, inventory stocks and the finance required to carry them will be the most likely response of local suppliers to construction of the pipeline through their areas.

Income and Trade

While pipeline labor contracts are expected to include such fringe benefits as health insurance, vacation and sick pay, it is estimated that each worker will work an average of 21 days per month, earning $1,785. This estimate allows some time for travel between jobs. Multiplying the average earnings ($1,785/month) times the man-months of employment yields estimated pipeline construction income as shown in table 3.1.4.9-1.

For purposes of comparison, earnings in the contract construction sector and total personal income of each county are also shown. Because construction workers are not permanent, they probably will not spend as much of their income locally as do residents. It is also possible that the county of domicile (and consequently income expenditure) will not be the same as the county where the income is earned. For this reason, trade levels are shown only by corridor region and state component in table 3.1.4.9-1.

In 14 of the 26 counties, income generated from pipeline construction will augment construction industry earnings by 10 percent or more. In 10 counties, personal income will be increased by 1 percent or more. The expenditures from this income are not expected to be regionally significant as is shown in table 3.1.4.9-2.

In addition to expenditures for goods and services by construction workers, each pipeline spread will generate other actions affecting the local economy. Road and other transportation systems will be affected as the contractor has pipe delivered and stored along the proposed route at approximately 30-mile intervals. The roads used will be the same as previously used for pipeline construction and are not expected to be seriously impacted. For each spread the contractor will rent storage space for pipe and equipment, plus maintenance sheds and field offices.

The contractor could also expect to spend $2,000 per day per spread for diesel fuel, or about $3,500 per mile. Estimates of expenditures for diesel fuel are shown in table 3.1.4.9-3.

Income of the five permanent employees associated with the operation and maintenance of the completed pipeline is expected to average about $15,000 per year per employee in 1977.

Table 3.1.4.9-1 Income generated by pipeline construction (PGT-PG&E), construction industry and total personal income 1/

State	County	Pipeline Mileage	Pipeline Construction Income 2/ ($1,000)	Contract Construction Earnings 3/ ($1,000)	Total Personal Income 4/ ($1,000)
Idaho	Boundary	42	990	1,354	20,440
	Bonner	40	942	3,725	56,940
	Kootenai	25	589	10,802	140,160
Wash.	Spokane	38	895	68,719	1,267,280
	Whitman	61	1,437	5,435	154,760
	Columbia	4	94	1,214	18,980
	Walla Walla	50	1,178	12,904	188,960
Oregon	Umatilla	34	801	9,006	183,960
	Morrow	30	707	613	20,440
	Gilliam	32	754	354	8,760
	Sherman	18	424	1,121	8,760
	Wasco	23	542	8,544	84,680
	Jefferson	31	730	1,506	32,120
	Crook	9	212	1,267	39,420
	Deschutes	51	1,541	10,005	132,860
	Klamath	124	3,653	8,920	213,160
Calif.	Modoc	40	942	1,957	30,660
	Siskiyou	22	518	9,091	144,540
	Shasta	61	1,437	22,552	334,340
	Teharma	45	1,060	5,978	122,640
	Glenn	28	660	3,547	71,540
	Colusa	36	848	2,809	58,400
	Yolo	32	754	29,568	767,960
	Sacramento	4	94	165,160	3,147,760
	Contra Costa	2	48	237,565	3,236,820
Total		911	22,872	642,296	10,885,760

1/ For purposes of comparison, all income data have been converted to 1975 dollars by use of GNP inflator/deflator factors obtained from Wharton Economics Forecasting Assoc. Adjustment does not include population-employment changes from base year of measurement.

2/ Based on 1977 labor cost estimates per mile of pipeline plus construction of compressor stations.

3/ Estimated from employment data of the 1970 Census of Population.

4/ 1970 Census of Population.

Table 3.1.4.9-2 Employment summary

Work Objective	Probable Number of Employees	Probable Work Duration*	Total Man-Months of Employment Generated
Pipeline Construction	1,141	12 months	13,672
Compressor Station Construction	72	12 months	864
Measurement and Maintenance Station Construction	15	2 months	30
Operation and Maintenance	5	Permanent	--
Induced (Secondary) Employment	2	Permanent	--

* Assumes that each spread constructs two 100 mile sections. Actual employment levels will vary with specific construction schedule followed.

Table 3.1.4.9-3 Estimated goods and services expenditures and total retail and services receipts

State	Retail and Service Receipts	Estimated Crew Expenditures	Contractor Fuel Expenditures
Idaho	143,956	1,008	375
Washington	163,857	1,442	536
Oregon	573,266	3,881	1,232
California	4,937,862	2,818	1,047
Total	6,818,941	9,149	3,071

For purposes of comparison, all data have been converted to 1975 dollars by use of GNP inflator/deflator factors obtained from Wharton Economic Forecasting Assoc.

Another income related impact is the loss of agricultural and forest production within the proposed right-of-way. This topic is also treated in section 3.1.4.6, Vegetation, and section 3.1.4.11, Land Use. Only the economic aspects are analyzed here.

While the productivity of range land could be adversely affected within the proposed route, there is no expectation that livestock stocking rates will be reduced. Consequently, adverse economic effects will be slight or nonexistent. In the past, the Applicants have not annually cleared their right-of-way after construction has been completed.. The 1969 crop value adjusted to a 1975 dollar base indicates an average annual crop production value in the area of the right-of-way of $758,000. Whether production loss extends for more than 1 year depends upon the type crop affected. The permament additional acreage lost to timber production, about 400 acres (see section 3.1.4.11) would have yielded, over a production cycle of 90 to 100 years, an equivalent value of $450,000 at 1975 prices. Further production from this land area could be expected after the life of the pipeline, estimated at from 20 to 50 years.

State and Local Tax Base

During the construction phase, tax benefits to State and local governments along the proposed route will come primarily from sales and motor fuel taxes. These benefits will be transitory with little significant long-term impact.

Personal and corporate income taxes will generate revenues to the states. However, because much of the labor force will be from out of state, personal income tax revenues will accrue outside the regions.

Property taxes on the proposed pipeline, compressor stations and improvements will provide the primary tax benefits to the counties through whose jurisdiction the pipeline will pass. In order to estimate the potential impact of the proposed pipeline on the tax base in each county, an estimated cost or cash value of the pipeline per mile was assigned. This was multiplied by the expected annual tax rate. Available data suggest that the average annual tax will be about 2 percent of the cash value. Since both the assessed value as a percent of cash value and the county tax rate vary from state to state and county to county, the actual tax paid in a particular county will be somewhat more or less than that estimated at the 2 percent rate. Cash value will change in time due to physical and economic depreciation or appreciation of the facilities.

Table 3.1.4.9-4 shows the estimated cash value of major pipeline facilities for the proposed pipeline, total assessed valuation, tax revenues, and the estimate of average annual property tax revenues from the pipeline.

Economic Trends and Development

There is no current indication that ongoing trends will be changed or modified due to: (1) the short-term nature of pipeline construction; (2) limited number of permanent employees; and (3) most of the gas being transported going to markets either away from or at the end of the corridor region.

Table 3.1.4.9-4 Estimated value of major new pipeline facilities, related tax base and revenues

State	County	Pipeline Mileage (42 in.)	Estimated Total Investment 1/ (1977)	Estimated Annual Property 2/ Tax	Total Assessed Valuation	Total County Property Tax Revenues
Idaho	Boundary	42	$34,146,000	$682,920	$ 15,236,457 3/	$ 1,244,660 4/
	Bonner	40	32,520,000	650,400	33,842,139	412,269
	Kootenai	25	20,325,000	406,500	59,542,779	1,536,981
Washington	Spokane	38	30,894,000	617,880	1,171,110,088 5/	35,522,493 6/
	Whitman	61	49,593,000	991,860	263,528,523	7,353,793
	Columbia	4	3,252,000	65,040	44,432,543	1,238,568
	Walla Walla	50	40,650,000	813,000	238,256,475	7,463,027
Oregon	Umatilla	34	27,642,000	552,840	437,964,989 7/	12,489,624 8/

1/ Calculated at the rate of a 1977 cash value of $813,000/mile for 42-inch pipeline.

2/ Based on an assumed annual tax rate of 2 percent of cash value.

3/ From Assessed Valuation--State Tax and Property Tax Levies by County--State of Idaho 1974.

4/ Computed from assessed valuation.

5/ 1973 Equalized Total Assessed Valuation.

6/ 1973 Tax Roll, Current Property Taxes by County, Washington Department of Revenue.

7/ From Oregon Department of Revenue Summary of Assessment Rolls, 1973.

8/ From Oregon Department of Revenue Comparison of Property Tax Levies by County (1973-74 Tax Year).

(cont.)

State	County	Pipeline Mileage (42 in.)	Compressor Stations	Est. Total Investment (1977)	Est. Annual Property Tax	Total Assessed Valuation	Total County Property Tax Revenues
Oregon	Morrow	30	--	$ 24,390,000	$ 487,000	$ 99,362,903 1/	$ 2,051,920 2/
	Gilliam	32	--	26,016,000	520,320	52,915,994	1,112,799
	Sherman	18	1	22,134,000	442,680	62,929,884	1,184,353
	Wasco	23	--	18,699,000	373,980	243,972,585	5,996,799
	Jefferson	31	--	25,203,000	504,060	197,946,261	3,609,284
	Crook	9	--	7,317,000	146,340	132,380,755	2,251,521
	Deschutes	51	1	48,963,000	979,260	451,283,738	10,299,550
	Klamath	124	2	115,812,000	2,316,240	720,951,820	10,055,139
California	Modoc	40	--	32,520,000	650,000	44,422 thousand 3/	3,479,000 4/
	Siskiyou	22	--	17,886,000	357,720	153,673 "	11,401,000
	Shasta	61	--	49,593,000	991,860	290,630 "	24,386,000
	Tehama	45	--	36,585,000	731,700	113,656 "	9,777,000
	Glenn	28	--	22,764,000	455,200	83,747 "	6,295,000
	Colusa	36	--	29,268,000	585,360	81,397 "	5,800,000
	Yolo	29	--	23,577,000	471,540	279,619 "	31,353,000
	Solano	32	--	26,016,000	520,320	409,606 "	41,595,000
	Sacramento	4	--	3,252,000	65,040	1,307,471 "	168,810,000
	Contra Costa	2	--	1,626,000	32,520	1,950,295 "	251,249,000

1/ 1973.

2/ 1973-74 Tax Year.

3/ 1973-74 Fiscal Year.

4/ 1973-74 Tax Year.

Waste Generation

The environmental impact of the many types of wastes generated during construction will depend largely on how they are handled. All states along the route have regulations that prohibit unregulated dumping so if those regulations are followed, the primary impact will be on the refuse disposal facilities which exist near the route. The amount of waste developed during a large construction project has a great impact on small facilities that typically exist in rural areas. No information was available on the capacities of local waste disposal facilities along the route to handle the waste generated. Typically, the contractor is required by the applicant to clean up wastes during and after construction. The contractor will make arrangement locally to accept these wastes on a landowner property or at a waste disposal facility. Thus, the impact discussed below is based upon reasonable estimates only.

Construction Generated Wastes

Non-merchantable trees and brush must be disposed of. If states restrict open burning it may be necessary to dispose of non-merchantable timber in authorized waste disposal facilities. This will call for a large number of truckloads and will consume considerable fuel, but it is likely that the impact will be small. In the event open burning is permitted, the impact on waste disposal facilities will be negligible.

Grading operations will produce excess materials. Much of the material will not be suitable for use in building access roads and must be disposed of (as high as 25,000 cubic yards per mile) along with the excess material displaced by the pipe (about 6 million cubic yards). The method proposed by the Applicant is spreading that material along the right-of-way. Since some of this material will be rocky and might otherwise be disposed of on valuable farmland, it will be necessary to haul it off to disposal sites. Onsite disposal of suitable excess earth materials could be accomplished, in some cases, by recontouring of the ground surface. In areas where worked-out sand and gravel pits are available, hauling excess earth materials for restoration purposes of the old pits might be an alternative. It is estimated that the primary impact of construction wastes will be caused by truck traffic which will in turn have small noise and air quality impacts.

Waste construction materials will need to be carried from the pipeline route. These wastes can be scrap pipe, concrete, steel, and lumber. It is estimated that as much as 100 cubic yards per mile may be generated; this is largely dependent upon the specific construction techniques used.

Human Generated Wastes

The amount of these wastes is directly related to the number of people involved in the construction. Since there are both employees (which can be estimated) and nonemployees such as dependents, support personnel and temporary commercial establishment employees (which are more difficult to estimate), the amount of various human wastes generated cannot be estimated directly. Because the construction moves so rapidly, it is not likely to develop a large secondary influx of people so the construction spread of about 300 people plus another 10 percent of support personnel would generate about 1,650 pounds of garbage per day (5 lbs/person/day) or 4 cubic yards of compacted waste for haul to a local waste disposal facility. This could be handled quite easily in local communities.

Estimates of liquid waste generated vary between 25 and 75 gallons per person per day. In a typical situation, 50,000 to 100,000 gallons of additional sewage will be generated each day. The contractor will have the task of providing the necessary water supply and disposal facilities on construction sites. Regulations on this type of waste disposal appear adequate to insure that minimal impact will occur. There is no indication that previous pipeline construction has caused a significant impact. See section 3.1.4.5, Water Resources, for further discussion of liquid waste impacts.

Road Maintenance Needs

During the construction phase, there will be substantial heavy truck traffic. This traffic will carry pipes from stockpiles to the site, construction equipment to and from the site, miscellaneous materials to, and wastes from, the site. For the most part roads throughout the area are designed to carry very large loads and consequently are not expected to deteriorate. There are no reported problems from the previous construction.

Market Area

The beneficial impact of the project is that PG&E's California service area of 94,000 square miles and 8.6 million people will continue to be served with a relatively low cost and clean energy supply. Its 2.5 million customers will not have to find alternate energy sources which undoubtedly would be more expensive. Finally, there would be a greater assurance of the natural gas supply because the source of natural gas is domestic rather than foreign. This is most important to an area such as the State of California where 83 percent of the energy needs are imported from outside the state.

3.1.4.10 Sociological Factors

Because of the interrelationships between the social and economic impacts of the proposed action, they have been combined in section 3.1.4.9. See that section for discussion of sociological factors.

3.1.4.11 Land Use

Historic Land Use Trends

The proposed project will have minimum impact on historic land use trends since it will parallel an existing natural gas pipeline. The land is already dedicated to right-of-way purposes.

Short-term impacts defined in this section are those effects usually occurring within a 5-year period. Short-term impacts usually are associated with construction of the proposed pipeline. An example of short-term impact would be an agricultural crop that was removed by the clearing for the proposed pipeline. The following year the crop is planted and harvested.

Long-term impacts are those effects on land uses that would remain for the lifetime of the project or even longer. The impacts are associated with construction and operation of the proposed pipeline. An example of long-term impacts would be the land area of a farm that was used for a compressor station site and removed from agricultural production for the life of the project.

Based on the Applicants' acreage requirements, and not considering overlap of the existing pipeline, total area required is 11,000 acres of which 9,500 are private lands. (Refer to table 1.1.4.4-1). Except for the John Day River crossing, most construction activities will occur on 70 feet of the Applicants' existing 100-foot wide right-of-way across private lands for a total of 7,000 impacted acres. Consequently, surface disturbance will be reduced on easements across private lands from 9,500 to approximately 7,000 acres. More than 6,500 of the 7,000 acres were previously disturbed during construction of the existing pipeline. Based on the application of a 53.5-foot wide permanent right-of-way and 25-foot PGT and 40-foot PG&E temporary working area across Federal lands, total acreage required, not considering overlap of the existing right-of-way, is about 1,150 acres. Considering the overlap, the total amount of new permanent right-of-way across Federal lands is 470 acres. Including the new John Day River crossing, previously undisturbed acreage includes 20 acres (Federal) plus 220 acres (private) of permanent right-of-way, and 550 acres (Federal) plus 350 acres (private) of temporary working area for a total of about 1,150 acres.

Most of the area required for the new permanent right-of-way across Federal lands was previously impacted as a temporary working area during construction of the existing line.

Current Land Use

Commercial Forest

Commercial forest lands impacted by the proposed project are located in northern Idaho along the Moyie River; central Oregon from Bend to Klamath Falls; and northern California in the Burney area.

An additional 400 acres of new permanent right-of-way will be removed from timber production which is not dedicated in the existing right-of-way. The impacts on commercial forest lands are negligible.

Agriculture

The proposed project will not impact any additional new agricultural land which is not already dedicated in the existing right-of-way. The impacts will be minimum since 1 or 2 years growing season could be lost for producing a crop, depending on season and duration of construction.

The Bureau of Reclamation projects impacted by the proposed project are shown in Figure 2.1.4.11-2. The impacts are considered to be insignificant because the water supply or distribution systems involved will be crossed by boring or tunneling during the construction phase.

Industrial, Commercial and Residential

The proposed project will not impact any new additional industrial, commercial or residential land which is not already dedicated in the existing right-of-way. The impacts on adjacent industrial, commercial and residential lands will be minor.

Minerals, Recreation, Federal and State Reserves

The proposed project will not impact any new additional mineral lands which are not already dedicated to the existing right-of-way. Also no recreational development sites or additional Federal and State reserves will be impacted by the proposed pipeline route. Consequently, the impacts on minerals, recreation and Federal and State reserve lands are considered to be minor. Refer to Sections 3.1.4.6 and 13 for additional details concerning vegetation and recreation and esthetic resources, respectively.

Grazing, Watershed and Wildlife Lands (Conservation Lands)

The proposed project will impact an additional 290 acres of new permanent right-of-way which are not dedicated in the existing right-of-way. Consequently the impacts on the grazing, watershed and wildlife lands will be negligible.

Transportation Facilities

Highways and Roads

The impacts on highways and roads along the project route will be minimal since they normally will be crossed by boring or tunneling during the construction phase. Additional impacts on highways and roads will happen as a result of heavy equipment transporting supplies and materials from supply points along the proposed route but these are expected to be negligible.

Railroads

The 49 railroad crossings will have minor impacts on the railroads since they will be crossed by boring or tunneling during the construction phase.

Water-Based Transportation

The 26 river crossings will have minimal impacts on water-based transportation. At most, the construction will temporarily delay river traffic.

Air Transportation

There will be no impact on the air transportation service along the proposed project route.

Transmission Facilities

The proposed project will have minimum impact on the transmission facilities for natural gas, petroleum, and Bonneville Power Administration and PG & E high-voltage transmission lines.

Land Use Planning

The proposed project will have no significant impact on land use planning since the land along the proposed route is already dedicated for right-of-way purposes.

Expected and Potential Trends

The proposed project will not have any significant impact on expected and potential trends since an irrevocable commitment of the land has already been dedicated.

3.1.4.12 Archeological, Historic, and Other Unique Values

Factors to consider in assessing the magnitude of the impacts of the proposed pipeline on historical and archeological values are:

1) The degree of investigation given the site.
2) The value of the known or yet-to-be discovered sites in terms of increased historical, cultural, and archeological significance.
3) The in-place public interpretive value of each site.

Methodology has improved in American archeology since archeological sites along the present route were surveyed and salvaged in the 1960s. Research aims and techniques have also changed during this period. It is now understood that with careful planning and execution, there can be a greater reduction of cultural resource losses.

The archeologist has learned where to look for sites based upon the environmental conditions surrounding past findings. However, it is presumptuous to assume that the location of all sites can be predicted based on the environmental conditions of past findings. There are areas containing remnants of value which cannot be predicted. These are hidden sites that may not be located even with a new field investigation. They could be exposed during or after construction.

During construction of the existing 36-inch pipeline, two sites were destroyed. Investigation of the existing right-of-way has disclosed the identification of 24 additional sites. Future trenching probably would disclose others.

Should the permit be issued, archeological and historical sites would not be located in time to be protected and losses minimized unless those familiar with such values are present to identify the site during the various construction phases. Sites identified prior to construction could be avoided by route realignment or salvaged by qualified archeologists and historians.

Secondary impacts would stem from increased public knowledge and access to identified and discovered sites. All sites, based upon the experience of visitor use on public lands, would be interesting to some and vandalized by others.

The Lewis and Clark Trail on the Snake River, will be crossed by the proposed pipeline. However, crossings by the existing pipeline have already swept away any evidence of historic trails that could have been present within the 100-foot right-of-way. No known additional historic sites will be impacted by construction of the proposed pipeline.

3.1.4.13 Recreational and Esthetic Resources

Recreation Facilities, Areas and Resources

The proposed pipeline will not pass directly through developed recreational sites. The impact of laying and operating the proposed pipeline parallel to the existing pipeline is considered minor since the initial impact of the proposed project on recreation resources occurred during construction of the existing pipeline in 1961. Approximately 90 percent of the area needed to construct the proposed pipeline was disturbed in constructing the existing pipeline.

An estimated 1,150 additional acres will be disturbed in building the new pipeline. During the construction phase, the major temporary impact on recreation will occur at river and stream crossings. Recreational boating and fishing will be somewhat reduced by operation of construction equipment and the accompanying effect on water turbidity. This impact is expected to be minimal since river crossing operations normally are completed within a few days.

Construction activities will temporarily drive game from the area but with restoration of the corridor, hunting opportunities will return to preconstruction levels. If construction occurs during the nonhunting season, there will be little effect on hunting opportunities. Similar impacts are expected for those recreationists who are viewers of wild birds and animals.

Some abandoned access roads from the 1961 construction will be made serviceable for the new constructions. Depending on land owners, some of these roads will be available to recreationists.

Increases of noise, fumes, dust, vehicular traffic, and humans limit opportunities for recreationists but it is not possible to measure these impacts for several reasons, one of the most important being no determination as to the time of year construction will take place.

Operation of the parallel pipeline will have little effect on recreationists. An occasional (but not more than once a year) blowdown, lasting up to 45 minutes and audible up to 3 miles, may be distracting to some. Except for pipe repairs or replacements, other operational activities will not be increased because of the new pipeline. Pipe repairs or replacements will have impacts similar to new construction except on a greatly reduced scale and on a locally isolated basis.

A state-by-state resume of impacts follows:

Idaho

The U.S. Forest Service is presently studying the Moyie River Valley for possible classification under the Wild and Scenic Rivers Act. The adverse effects caused by the original pipeline crossings plus existing roads, a railroad, summer home development and an abandoned dam will influence the classification decision. Expanding the width of the existing right-of-way (only across National Forest lands) an additional 40 feet may not be the determining factor on the river's future classification. Of the 20 miles of existing right-of-way along the Moyie, nearly 15 miles are on private lands where no widening of the right-of-way is necessary to construct the proposed pipeline.

Little or no impacts related to the operation of the pipeline will occur to recreation activities associated with the Purcell Trench area. During construction there will be the usual annoyances related to construction activities such as travel delays, increased traffic, etc., but these will be temporary. The large and diverse recreational opportunities in northern Idaho will permit recreationists to use alternate recreational sites close by if construction inconveniences become too annoying. Pend Orielle Lake is too far removed from the pipeline to be impacted.

Washington

There are no visible segments of the Kentucky Trail, Texas and Mullan Roads, or Lewis and Clark Trail. Impacts related to the specific crossings of these historic trails were sustained during construction of the existing pipeline.

Construction activities will temporarily decrease the quality for sightseers along the Snake River as well as the quality of recreation experience for boaters, swimmers and fishermen. The traffic congestion, noise, dust and human congestion caused by construction vehicles most probably will interrupt some use of the Lyons Ferry State Park on the Snake River. This adverse impact will persist only during the construction phase of the project.

The area along the Palouse River being considered as a natural area is more impacted by existing railroads and the existing pipeline than by the proposed pipeline. Consequently, final classification of the area will not depend on the existence of a second pipeline two miles from the proposed area.

Oregon

Cultivation has eliminated much of the visible segments of the Oregon Trail although short segments of ruts exist in the vicinity of its intersection with the proposed pipeline. As is the case with other trails, visible segments at the crossing, if any, were destroyed in constructing the existing pipeline.

The new crossing of the John Day River probably will not have a serious effect on the future classification of the river as a National, wild, scenic, or recreational river even though the crossing now being proposed is designed to have the least impact on the canyon's natural state. The proposed crossing is at a point accessible by a jeep road.

The proposed pipeline will pass about 400 feet from the southeastern corner of the Lava River Caves State Park. An unused section of the caves is some 60 feet under the existing route and Highway 97. Severe and untimely blasting could pose a safety hazard to some of the 64,000 visitors who visit the caves annually. There is also the possibility that blasting will damage the walls and ceilings of the adjoining tubes, which would be a permanent impact. No reported damage occurred when the Applicants blasted the trench for the existing pipeline in 1961.

The proposed route crosses an edge of the lava flow and a 50-foot fissure in the lava at Cinder Butte. Construction of the proposed pipeline will temporarily interrupt the visitors using portions of the lava flow.

California

Crossing the Pacific Crest Trail will pose a temporary impact during construction. Operation and maintenance are considered to have an insignificant impact on the trail or people hiking the trail.

The segment of the Sacramento River from Keswick Reservoir to Sacramento is another area identified as a potential addition to the National Wild and Scenic Rivers System. However, it is felt that the proposed pipeline in addition to the many highways, railroad, and other developments along the river will not adversely affect the final classification. For the most part, Interstate 5 impacts the esthetics of the river to a greater degree since it is closer to the river than the existing and proposed pipelines.

The Lava Beds National Monument is too far distant to be affected by the pipeline except for temporary traffic delays during construction. The situation with respect to the isolated Mayfield Ice Cave is similar to the Lava River Caves State Park in Oregon. Construction activities are a potential danger to visitors and the ice cave itself.

The widening of the existing pipeline 2 miles from the Baker Cypress and Lava Rock area will not be a determining factor in its designation as a primitive area. Operation of two parallel pipelines near this area will not impact its use as a primitive area.

Impacts to the private recreational developments in the Fall and Pit River areas, including Lake Britton, are similar to that in northern Idaho. Construction activities will have temporary impacts, but long-term impacts will be negligible. While it is difficult to predict human nature, it is estimated that no more than 25 percent of the recreationists will be impacted enough to go elsewhere even if construction takes place during the height of the tourist season.

Likewise, hunting and fishing enthusiasts may experience reduced numbers of fish and game along the right-of-way during and immediately following the construction period, but the impact will diminish locally and the situation will return to normal within 3 years.

As previously mentioned, river crossings, including the Sacramento and San Joaquin Rivers, will have adverse impacts mostly associated with construction. Consequently, these impacts will be short-lived for recreationists using the rivers. Pipeline operations will have negligible impacts on river recreationists.

Esthetics

Of the eight areas having the highest rating for variety and sensitivity, three are associated with river crossings. In these eight areas, only the John Day River crossing does not parallel the existing pipeline.

The John Day River crossing for the proposed pipeline was relocated from its originally proposed crossing to an area considered the least damaging to the canyon's esthetics.

Most of the permanent esthetic impacts related to constructing a new parallel pipeline were suffered when the original pipeline was constructed. With minor exceptions the only widening of an existing right-of-way will be across Federal lands. Since this involves less than 10 miles of the highest

rated esthetic areas, the impact is considered minimal. Likewise, considering that 60 percent of the existing right-of-way has the lowest scenic rating and 60 percent is not visible to the public, the overall adverse visual impact must be rated low.

While the overall impact is considered low, a few localized areas will be noticeably impacted for the duration of the project. The most serious adverse impact will be a "tunnel" effect through forests, especially at river or highway crossings on Federal lands.

Upon completion of construction there will have been a clearing to mineral soil, over the entire 917 miles of the right-of-way. This will constitute an adverse esthetic impact for varying periods of time. Within 14 or 15 years the entire right-of-way will appear as it does today, except for being a bit wider across Federal lands. In many instances, including agricultural areas, the location of the right-of-way will not be readily apparent after the first growing season.

3.1.4.14 Air Quality

Increased Air Pollutants

Gaseous Air Pollutants from Permament Installations

The compressor stations along the proposed route are the only permanent installations that will emit air pollutants continuously. The additional gas-turbine driven compressor capability to be added at existing stations along the route is as follows:

Compressor station	Location	Additional Horsepower
10	Kent, Oregon	12,500
12	Pauline, Oregon	12,500
13	Diamond Lake, Oregon	12,500
14	Bonanza, Oregon	12,500

When this additional capacity is added, the largest compressor installation affected by the proposed actions will be compressor Station 10, at 36,000 horsepower. It will emit about 0.55 ton per day of nitrogen oxides (NO_x) and about 440 lb per day of carbon monoxide (CO). Practically no other air pollutants will be emitted. These emission estimates are based on recently published reports from studies sponsored by the U.S. Environmental Protection Agency (Hare et al, 1974) and the American Gas Association (Springer et al, 1975), which indicated that NO_x is emitted from gas turbines at a maximum rate of about 0.50 lb NO_x per million Btu, and CO at a rate of about 0.20 lb CO per million Btu.

The highest NO_x emission rate measured for any gas turbine corresponds to a concentration of 71 ppm in the exhaust gas (Hare et al, 1974). When corrected to 15 percent excess O_2 in accordance with standards proposed by the U.S. Environmental Protection Agency, the highest equivalent NO_x emission rate is 130 ppm.

Air pollutants other than NO_x will not be emitted by the turbines in quantities that cause any measurable impact on the environment. Natural gas occasionally will be emitted from leaks, venting, and maintenance operations, but these will contribute no impact because the quantities are relatively small and the gas is much less dense than air.

The behavior of NO_x emissions in the atmosphere can be estimated from the dispersion correlations compiled by the the U.S. Environmental Protection Agency (Turner, 1970). From formula 3.3 of this document, and with dispersion coefficients given by

$$\sigma_y = A \cdot x^B$$

$$\sigma_z = A' \cdot x^{B'} ,$$

the downwind distance at which the maximum pollutant level will be experienced is given by

$$x_{max} = \left[\frac{H^2 \cdot B'}{(A')^2 \cdot (B+B')} \right]^{\frac{1}{2}B'}$$

where H is the effective height of the emitting source (in meters). It is appropriate to consider a "worst case" situation, assuming that winter conditions apply and that the most stable atmospheric conditions prevail, with an effective stack height of H = 20 m. For this case,

$$x_{max} = 1560 \text{ m}$$

$$(C_{NO_x})_{max} = 21.9 \ \mu g/m^3$$

where x_{max} = downwind distance at which maximum pollutant level is experienced, at ground level, and $(C_{NO_x})_{max}$ = ground level concentration of NO_x at distance x_{max}.

This estimate is very sensitive to the value of the effective emission height, H. If the effective emission height can be increased by 50 percent, by means of (e.g.) imparting sufficient velocity to the exhaust gas, then this estimated concentration is reduced to about one-quarter of the value given above.

On an annual average basis, the concentration of NO_x contributed to the environment by the planned additional compressor drive capability will be on the order of 1 $\mu g/m^3$. This estimate is based on an assumption of effective emission release height of 20 m; any increase in this height will lower the NO_x concentration.

Permanent Contributions of Dust

Two segments of the pipeline route are susceptible to creation of particulate air pollution as a result of wind erosion of disturbed soil (see section 2.1.4.1). These zones are (1) a segment about 250 miles long in the Columbia Plateau portion of the route and (2) a segment about 85 miles long near Bend, Oregon.

Such a source of pollutant approximates a classical "line source." For the case of poorest atmospheric stability (i.e., highest atmospheric mixing rate), the wind erosion described in 2.1.4.4 may produce dust concentrations that are relatively high near the source point, as estimated by formula 5.20 of Turner, 1970. The maximum dust concentrations may approach 200 $\mu g/m^3$, but they are expected to fall to low levels (approximately 10 $\mu g/m^3$) within 1 mile (PEDCO, 1968).

Air Pollution from Combustion of Fuels by Vehicles

During construction operations along the proposed route, a total consumption of about 12 million gallons of gasoline and diesel fuel is anticipated. Combustion of this fuel is capable of generating about 4.5 million pounds of nitrogen oxides (NO_x) and about the same amount of CO. The generation of sulfur dioxide will be about 30,000 lb, and of hydrocarbons about 20,000 lb. These figures are based on reported emission figures for construction vehicles (Hare and Springer, 1973).

If several construction vehicles are concentrated at a single point, for an extended period, under the most stable atmospheric conditions, there is a possibility that NO_x concentrations may approach the limits imposed by the National Ambient Air Quality standards (see section 2.1.4.14). However, this possibility is remote. There is no reasonable probability that any air pollutants other than NO_x will approach objectionable levels.

References

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PEDCo Environmental Specialists, Inc., Investigation of Fugitive Dust Sources, Emissions, and Control. Report to the U.S. Environmental Protection Agency. Task Order 9 (1968).

Hare, C.T., and K.J. Springer, Exhaust Emissions from Uncontrolled Vehicles and Related Equipment Using Internal Combustion Engines. Part 5. Farm, Construction and Industrial Engines. Report No. APTD-1494, U.S. Environmental Protection Agency. San Antonio, Texas, Southwest Research Institute (Oct. 1973).

3.1.4.15 Environmental Noise

Construction Phase

The construction phase will produce both indirect and direct noise impacts. The indirect noise impact will be due to the road traffic generated by the project and the direct impact will be the construction site noise.

Road Traffic

The primary cause of noise impact due to road traffic will be the heavy diesel trucks hauling construction equipment and pipe. Since most of the construction equipment will remain on the site, except when hauled around

major waterway obstacles, the pipe hauling operation is estimated to creat the largest noise impact. The storage areas have not been identified, but railroad delivery points can be reasonably identified and related to potential haul roads for access to the pipeline right-of-way. The majority of haul roads will be rural dirt roads where, even though the population density is low, the ambient noise levels are also very low so that audibility of the trucks will extend for long distances.

It is not possible to make a detailed estimate of the total noise exposure of the local populace to the hauling truck traffic, but several communities will be affected as the trucks pass through them en route to the construction site. The communities are listed in Table 3.1.4.15-1. Despite the rural nature of the route there is still a significant number of people (75,000) who will be exposed to the noise of the diesel trucks. There will be several trips per hour on a normal workday during the period pipe is being hauled through a community. Some annoyance will arise which will be related to the combination of noise, dust, and other factors. Because there are no criteria for this type of annoyance, no specific evaluation of the impact can be made.

Right-of-Way Construction

Construction of the pipeline will require large numbers of heavy equipment which will operate in groups doing various phases of the construction. Most of this equipment will be diesel engine powered. Typical noise levels (in dBA at 50 feet) of construction equipment are given in Figure 3.1.4.15-1 (EPA, 1972). These are levels that are found while the equipment is being used and would represent those levels observed on the pipeline construction site. It is estimated that the welding equipment would be acoustically similar to stationary air compressors.

The energy mean of L_{eq} values measured at 24 sites during excavation (corrected to a distance of 50 ft) is 84 dB (New York State Department of Environmental Conservation, 1974). Using this level as representative of the day-night sound level (L_{dn}) at 50 ft (since there is no nighttime construction planned), it is predicted that a total of 4,558 people reside within an area which will be impacted by L_{dn} in excess of the U.S. Environmental Protection Agency (EPA) goal (55 dB) for protection of human welfare (EPA, 1973).. Therefore, it is predicted that a total of 1,636 people will be highly annoyed by the construction noise and 131 households will make complaints about the noise. Table 3.1.4.15-2 provides the impact of pipeline construction noise on people in the states through which the proposed pipeline will pass.

Blasting and Vibration

Blasting operations during the construction phase will produce direct impacts on nearby structures. Drilling and blasting will be required where trenching through rock cannot be accomplished by ripping and removing the loose material with a backhoe. The detonation of explosive materials induces transient motion in the rock which is then transmitted through the surrounding rock and through any overlying or underlying strata. It is this motion, referred to as ground motion, which directly or indirectly damages structures. Direct damage to structures occurs when the motion produces stress levels sufficient to cause structural failure such as cracking of foundations, loosening of mortar and other damage to the primary structure. Safe limits of ground motion from blasting (Crandell, 1949; Hendron and Oriard, 1972; Soliman, 1973; and Steffens, 1966) for structures, building components, and sensitive equipment have been established at an acceleration

Table 3.1.4.15-1 Communities Potentially Noise Impacted by Pipe Hauling Trucks

State	Communities (Population)			Estimated Population Exposed
Idaho	Rathdrum (741) Cocolalla (20) Colburn (50) Bonners Ferry (2,796)	Athol (190) Westmond (unk) Samuels (unk) Addie (unk)	Careywood (25) Algoma (unk) McArthur (unk)	3,922
Washington	Eureha (20) Mt. Hope (unk)	LaCrosse (426) Freeman (100)	St. John (575)	1,140
Oregon	Malin (486) Chiloquin (826) Chemult (400) Redmond (3,721) Willowdale (unk) Ione (355)	Bonanza (230) Kirk (unk) Crescent (450) O'Neil (unk) Shaniko (0)	Dairy (40) Beaver Marsh (80) Bend (13,710) Madras (1,689) Condon (973)	23,000
California	Tionesta (10) Whitmore (15) Willows (4,369) Dunnigan (100)	White Horse (0) Red Bluff (8,200) Williams (1,570) Vacaville (26,600)	Burney (2,190) Orland (2,885) Arbuckle (1,040) Dover (0)	47,000
			Total	75,000

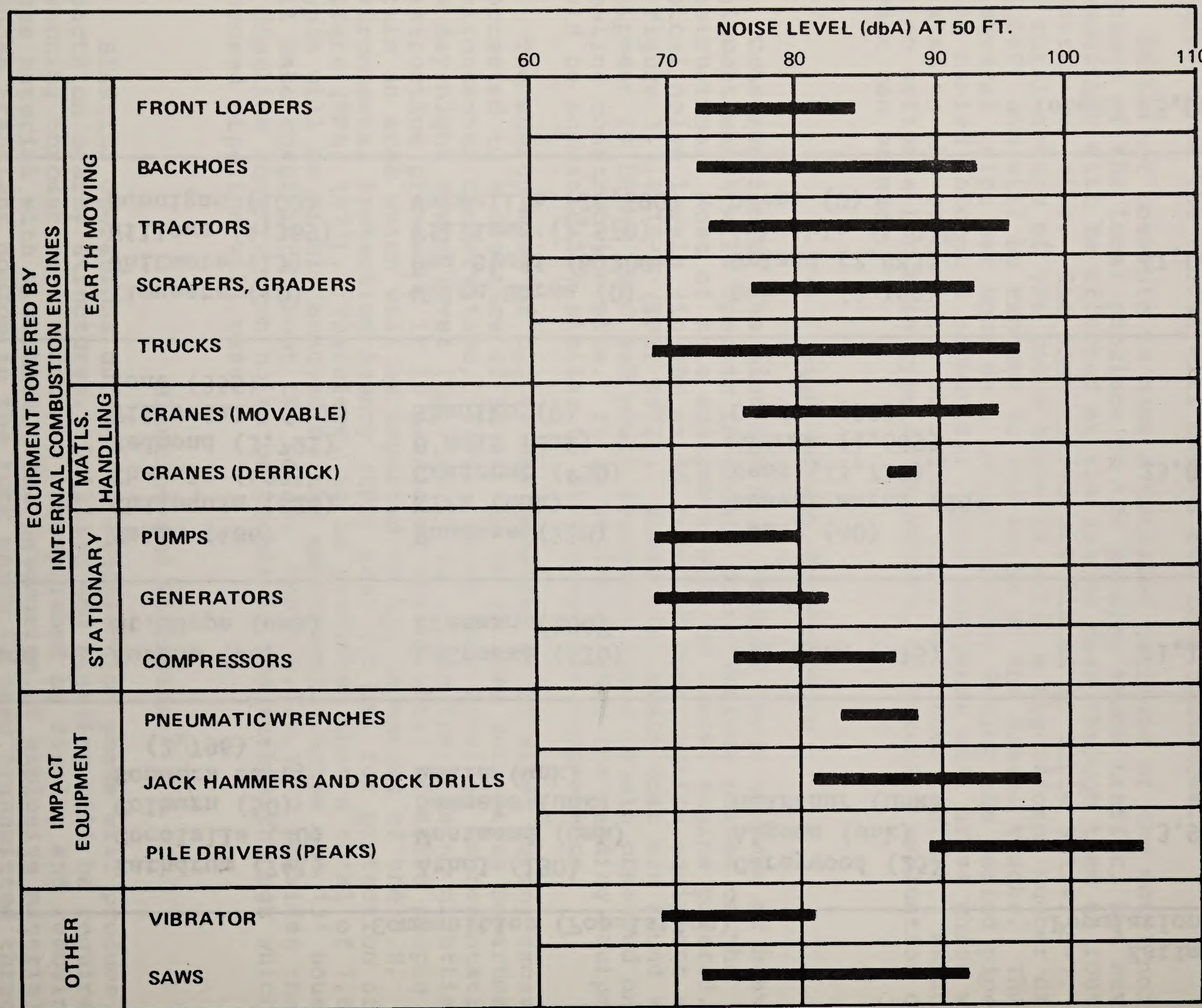

Figure 3.1.4.15-1 Construction equipment noise ranges

Table 3.1.4.15-2 Impact of Pipeline Construction Noise on People

	Estimated Number of People Residing Within $L_{dn} > 55$ dB*	Estimated Number of People Who Will be Highly Annoyed	Estimated Number of Complaints
Idaho	1,318	477	38
Washington	307	143	11
Oregon	1,333	458	37
California	1,600	558	45
TOTAL	4,558	1,636	131

* A day-night sound level (L_{dn}) of 55 dB has been identified by the EPA as the maximum level permissible for protection of human welfare. Corrections for normalizing L_{dn} cancel out.

of 38.6 inches per second per second from 5 to 15 Hz and a velocity level of 0.4 inch per second above 15 Hz. Below these levels structural failure generally does not occur but, rather, a secondary effect may occur which is the settlement or compaction of soil caused by ground motion.

Under sustained vibratory loads or repeated impacts such as caused by blasting operations, the internal structure of soils may change, thereby producing settlement of surface or possibly a reduction in strength. Loose, saturated cohesionless soils are particularly susceptible to compaction by impacts or vibration.

For example, damage from traffic-induced ground motion in medieval cathedrals of England and Wales has been investigated (Crockett, 1963), and predominant cracking and settlement were reported within those structures located adjacent to roads even though the ground motion levels were substantially below those specified above as safe limits.

Blasting at river crossings may have a fatal effect on nearby aquatic animals. Blasting will be required at several stretches along the right-of-way. About 3 miles of blasting may be required near Bonners Ferry, south of Bend, Oregon, Moyie River Valley, and in the lava flows at the California-Oregon border. No buildings along the route appear close enough to be damaged by blasting. Safety aspects of blasting are discussed in Section 4.1.4. Since the proposed route will parallel an existing line, there is a possibility that blasting may have severe adverse effects on that existing line. The concern for blasting stems from the fact that, since 1961, earth strains on the existing pipeline have resulted in unknown weld stresses superimposed on construction induced stresses and known design stresses. If these stresses have all been positive, the dynamic blasting stresses may be sufficient to cause failure. Although the possibility exists, it is likely to have low probability of occurrence.

Ground vibration caused by construction equipment and hauling trucks is estimated to be sufficiently small at any vibration sensitive buildings that no adverse impact can be identified. See Section 3.1.4.2 for the effects of blasting and vibration on creating rock falls and landslides.

Operation Phase

Compressor Station

The major potential noise sources of significance will be the compressor stations, which are long-term, continuous and fixed noise sources. There will be no construction of new gas compressor stations, but the horsepower of existing Stations 10, 12, 13, and 14 will be increased. Table 3.1.4.15-3 indicates that the impact of increasing the horsepower of these four stations will be minor.

The increase in horsepower of Station 13 is predicted to cause the sound level at the nearest dwelling (898 feet) to increase to 57 or 62 dBA. These levels will be in violation of the Oregon Noise Control Law (Oregon Revised Statutes, 1973, Chapter 467) unless special noise control is applied. Stations 10, 12, and 14 are not predicted to cause the station noise emissions to exceed the Oregon regulations.

Blowdown

Periodic venting of high pressure gas from the compressor stations or along the line would cause temporary but severe increases in sound level

Table 3.1.4.15-3 Impact of Changes in Existing Gas Compressor Station Noise Levels on People

Station Number	Status	hp*	Estimated Increase in number of people residing within L_{dn} 55 dB**	Estimated increase in number of people highly annoyed	Estimated increase in number of complaints
10	Existing	23,500	0	0	0
	Proposed***	34,250			
12	Existing	22,220	0	0	0
	Proposed***	33,340			
13***	Existing	21,960	20	3	0
	Proposed	32,940			
14***	Existing	18,185	3	1	0
	Proposed	29,185			

* hp is corrected for site elevation.

** A day-night sound level (L_{dn}) of 55 dB has been identified by the U.S. EPA as the maximum level permissible for protection of human welfare. No correction factors for normalizing L_{dn} apply.

*** Attenuation measures applied to gas turbine intake and exhaust.

(Table 3.1.4.15-4). These blowdowns will occur because of an emergency or as a part of maintenance checks or repairs. Blowdown of a compressor or of a pipeline section ending at a compressor station (unit blowdown) would occur at the station. Blowdown of a pipeline section would occur at each end of the section. It is estimated that the maximum noise would occur over a period of about 45 minutes for the pipeline and 5 minutes for the compressors. Planned station blowdowns are expected to occur about once per year.

Based on these data, ambient levels, and the approximate attenuation data given in Section 2.1.4.15, it is estimated that such a blowdown would be near 70 dB at 3 miles. Because of its relatively short duration and infrequent occurrence, it will cause annoyance but may not result in complaints to authorities. Blowdown at Station 13 will be quieter, because of noise silencing equipment.

The number of occurrences of blowdowns per year is not expected to increase as a result of this proposed action; therefore no increase in impact from blowdown noise is predicted.

References

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New York State Department of Environmental Conservation, 1974, "Construction Noise Survey." April.

U.S. Environmental Protection Agency, 1973, "Public Health and Welfare Criteria for Noise." Document 550/9-73-002, July.

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Hendron, A.J., and L.L. Oriard, 1972, "Specifications for Controlled Blasting in Civil Engineering Projects," Proceedings of the 1st North American Rapid Excavation and Tunneling Conference, Chicago, Illinois, June.

Soliman, J.I., 1973, "Criteria for Permissible Levels of Industrial Vibrations with Regard to Their Effect on Human Beings and Buildings," Proceedings, RILEM, Budapest, Vol. 1.

Steffens, R.J., 1966, "Some Aspects of Structural Vibration," Symposium, Vibration in Civil Engineering, London.

Crockett, J.H.A., 1963, "Traffic Vibration Damage in Medieval Cathedrals," Proceedings, RILEM, Budapest, Vol. I.

3.1.4.16 Hazards from Pipe Failure

The possibility of loss and damage due to pipe rupture is discussed in the Overview volume.

Table 3.1.4.15-4 Blowdown Noise*

Distance (ft.)	Station Blowdown 16" Valve Vent	10" Valve Vent	Unit Blowdown
100	115 dBA	113 dBA	108 dBA
300	105 dBA	104 dBA	98 dBA
1,000	94 dBA	93 dBA	87 dBA
3,000	84 dBA	82 dBA	75 dBA

* No silencing measures taken.

4 MITIGATING MEASURES INCLUDED In THE PROPOSED ACTION

4.1 ARCTIC GAS PIPELINE PROJECT

4.1.4 San Francisco Pipeline

In this chapter, each mitigating and/or environmental control measure proposed by the Applicant is listed and followed by an analysis and conclusion as to its effectiveness. Additional geotechnical or environmental control measures not proposed by the Applicant, but which, if applied, will significantly reduce adverse environmental effects are also discussed.

The mitigating measures, guidelines, rules, and regulations discussed in this section were developed for broad application. Many factors are conditionally applicable and could be interpreted as not necessary for the proposed project. Site-specific planning is necessary to identify the various resources involved and affected by the proposed project. Interdisciplinary teams with firsthand knowledge of local conditions and including specialists from the various involved Federal and State agencies could identify and develop specific site plans. These same agency and interdisciplinary inputs could develop contract specifications and necessary project monitoring on lands under Federal agency administration.

The Applicant's final construction, operation, and maintenance plans should be reviewed and approved by the appropriate agencies administering the lands prior to construction. Inspections and monitoring should be conducted in accordance with the approved plans.

4.1.4.1 Proposed Construction and Operation Monitoring

The Applicants have proposed three areas of concern which are to be monitored. They are archeological value protection, wildlife protection, and construction compliance. The monitoring of operations for safety compliance is presented separately and is covered in Section 4.1.4.3.

<u>Proposed Monitoring Measures</u>

Archeology

Proposed by Applicants

Arrangements will be made to have an archeologist available to make surveys of any artifacts or previously unknown archaeological sites discovered during initial grading and trenching.

Analysis

The Applicants have stated that their consultants will "use their discretion and judgment regarding the need to contact local, State, or Federal authorities." However, such a proposal does not totally conform with the procedures developed in the Historic Preservation Act of 1966, the Reservoir Salvage Act, and the Historical, Archeological, and Scientific Preservation Act of 1974.

Conclusion

The mitigation measure is not adequate and procedures developed in these relevant acts must be followed.

Wildlife

Proposed by Applicants

A biologist or environmental coordinator will be available to monitor construction to minimize fish kills and to identify and protect rare and endangered species, eyries of eagles and falcons, key waterfowl and upland game bird nesting and cover areas in cooperation with personnel from fish and game agencies.

Analysis

Biological monitoring at the time of construction will be of little value unless the monitoring is based on a detailed survey of specific habitat, cover, nesting, and spawning locations of rare and endangered species that is completed prior to final survey and design of the pipeline. To be effective, protective measures should be developed and recorded in the planning and design stages, to be considered by the landowners and appropriate agencies which approve the final pipeline location, design, and construction schedule.

Conclusion

The mitigation measure is not adequate since it does not include pre-construction planning and surveys.

State Fish and Game regulations require permits for stream crossings which list mitigation measures as prescribed by the Corps of Engineers. Waste disposal, sanitation, air, noise, and water pollution requirements are set and enforced by the Environmental Protection Agency, various State environmental and resource agencies, and requirements of numerous regional and County air quality and sanitation authorities.

Construction Regulations

Proposed by Applicants

Company inspectors will be on the site to see that contractors fulfill their obligations to the company and that construction procedures are carried out in accordance with Federal and State regulations.

Analysis

Company inspectors will be bound by the requirements of 49 CFR-Part 192, "Transportation of Natural and Other Gas by Pipeline--Minimal Federal Safety Standards." These regulations set standards for construction and operation performance including material strengths, welding specifications, valve installations, corrosion control, line marking, patrolling, numerous safety measures, and many other items. The company is required by Federal regulations to keep records of all required inspections and to provide these

inspection reports on request to the Materials Transportation Board, Department of Transportation.

State governments are authorized under PL 90-481, the "Natural Gas Pipeline Safety Act of 1968," to enforce Federal Regulations along with State requirements and carry out all necessary inspections.

Conclusion

In matters of safety and pipeline performance, Federal and State requirements give well defined parameters for minimum company inspection and monitoring requirements.

Company inspectors will not be alone in monitoring the many aspects of this massive construction project as required by Federal, State, and local agency regulations. If all of the stipulations and requirements are met during construction and operation, most of the potential adverse impacts on installing a parallel pipeline will be mitigated.

4.1.4.2 Prevention, Restoration, and Enhancement as Proposed by the Applicant

<u>Prevention</u>

Noise Abatement

Proposed by Applicants

Company construction specifications require that contractors' equipment comply with applicable Federal, State, and local noise and emission controls.

Analysis

Equipment emission controls should adequately control most air pollution problems except the generation of NO_x as discussed in 4.1.4.14. Federal and State standards for muffling of trucks and heavy equipment engines are liberal enough to permit an 88 dB(A) level 50 feet from the equipment. This can be a nuisance up to 250 feet and be heard up to 4,000 feet away.

Conclusion

The impacts are temporary and should not require any additional mitigation beyond existing controls cited by the Applicants.

Construction Traffic Control

Proposed by Applicants

Construction traffic will comply with applicable permits.

Analysis

State highway departments issue permits granting exceptions to limits on vehicles. County road authorities can, and often do, set operating hours for heavy trucking and place seasonal closures or weight restrictions on roads that would otherwise suffer damage due to situations such as subgrade softening thaws.

Conclusion

Compliance with State and local authorization will mitigate damage to roads and bridges.

Construction Across Waterways

Proposed by Applicants

In accordance with agency regulations governing stream and river crossings, special excavation, stockpiling and backfilling techniques will be used to minimize turbidity and siltation during construction. Because each river is a unique situation, these measures for each crossing will differ. For example, when recrossing the Snake River in 1970 for the parallel security section, select gravels were imported for backfill to minimize turbidity at the request of the U.S. Army Corps of Engineers.

Analysis

The Applicants state that permits will be acquired from State and Federal agencies (e.g., Fish and Game Departments, Corps of Engineers) and that where practical, stream crossings will be scheduled for summer months. Backhoe, dragline, or clam shovel techniques will be used on loose materials while bedrock will be drilled, blasted, and then excavated. Trench depths will vary from 8 to 16 feet depending on the scour and flow characteristics of the stream. Materials excavated from trenches will be redeposited in the trench with restoration to original grade. The Applicants further state they will "use their best efforts to comply with special permit stipulations...to minimize turbidity and siltation."

Trenches will fill back naturally via normal bedload transport within a few days of a high water flow period. Nevertheless, backfilling of the ditchline or small stream is desirable.

Conclusion

There is no practical way to avoid turbidity and siltation during a trenched river crossing. However, this is a short-term impact and with proper riverbank restoration, there should be no problem beyond the first year due to natural scouring and cleaning of river and stream beds.

Hydrostatic Testing

Proposed by Applicants

Water used for pipeline hydrostatic testing will be pumped from streams or other bodies of water in such a manner so as to minimize alteration of stream flow conditions, fish and wildlife resources, or the esthetic values

of the area. It may be necessary to import water by rail or truck. Where feasible, water will be pumped from one previous hydrostatic test section to the next. When the water is released after testing, it will be made available for local irrigation if so requested or discharged into a temporary holding pond or other approved water channels.

Analysis

As noted in Section 3.1.4.5, discharges of hydrostatic test water could cause substantial amounts of channel erosion, especially if released into dry channels or streams with small volume flows. Discharges are made from pipe sections up to 20 miles in length containing up to 950,000 cubic feet of water. The most satisfactory discharge method is to pump water from one hydrostatic test section to another. Reuse of hydrostatic test water should eliminate the need to withdraw large quantities of ground or surface water, thus avoiding undesirable drawdowns. Limiting releases to direct discharge points at major river crossings will also reduce erosion. Where it is necessary to discharge into smaller channels, the rate of discharge will have to be approved in advance. Locations for holding ponds will also have to be approved.

There are no data as to what measures will be taken in the event of pipeline breaks under the pressure of hydrostatic testing. Erosion and discharge of muddy waters into nearby drainages in such cases is largely nonmitigable.

Conclusion

The Applicants will be required to submit a detailed plan of hydrostatic testing and mitigation to the appropriate agency for approval prior to commencement of such operations.

Blasting

Proposed by Applicants

Blasting will be carried out in a manner so as to cause the least disturbance to people or animals. Appropriate governmental agencies and landowners will be notified in advance; overhead electric power transmission lines and telephone lines will be protected by the use of matting over the blasting areas.

Analysis

There have been little data supplied regarding blasting precautions. Blasting impacts can be mitigated by restrictions on construction timing. Stream crossing construction will usually be subject to such timing constraints by permits issued by State fish and game departments.

Blasting on the right-of-way that may affect nesting birds and other wildlife is subject only to operating plans approved by land managers. Operating plans can also restrict blasting to normal daytime hours in populated areas to reduce human disturbance.

Conclusion

The Applicants state that there is no danger to the pipeline from nearby mines and quarries based on 14 years experience on the existing pipeline. They do not assess potential impacts of pipeline construction blasting on such quarries, mines, or caves in the vicinity visited by recreationists. These locations should be identified and the probable effects of blasting assessed. Plans for blasting and blasting operations will have to be closely monitored by landowners and administering agencies.

Slope Stability (John Day River Crossing)

Proposed by Applicants

Further design studies and field investigations will be made in the John Day River Canyon area to detect areas of slope instability before construction.

Analysis

After concluding that the John Day River crossing landslide area has been naturally stabilized for several thousand years, the Applicants have listed a number of steps to minimize disturbance of slope stability. These include: keeping pipe and backfill loads on top of a slide area to less than 2,000 pounds per running foot, regrading two surface depressions on the bench to permit runoff of surface water, avoidance of blasting simultaneous charges, restricting water jetting and backfills, avoiding toe of slope trench excavation by routing, having a geotechnic engineer inspect and monitor the trenching operation, drilling observation wells in the landslide area to observe internal drainage, groundwater levels, ground movement, drainage of subsurface water from the slide mass, and finally, a periodic resurvey to detect any future shifting in the line.

The proposed mitigation measures are sound, but various timing aspects are questionable. For example, rather than monitoring of construction by a geotechnical engineer, a preliminary route selection survey should be made, including advance placement of test wells to determine whether the proposed route is safe for a final location. Construction pipeline referencing with periodic surveys for shifting would help give an early warning on potential rupture from slow cumulative mass movement, but would not provide timely warning of more rapid massive shifts.

Conclusion

The mitigating measures proposed by the Applicants are satisfactory but should include preconstruction studies. Other areas of slope instability along the pipeline route should be identified prior to construction and precautions taken to prevent activation of mass movement on slopes.

Wind Erosion

Proposed by Applicants

Snow fencing, straw bales, or other means will continue to be used to minimize wind erosion.

Analysis

The Applicants note that these measures are designed to mitigate wind erosion at Mile Posts 264 to 283 and 319 to 366 in the Columbia Plateau Province. They also propose to make every effort at reseeding and revegetating the right-of-way, providing fertilization on the irrigated lands between Mile Posts 270 and 283 and on the dry formed portion between Mile Posts 319 and 366. Noncultivated areas of the latter segment are proposed for treatment with sack breakers or diversion ditches to channel surface water and minimize erosion.

Conclusion

Snow fences and straw bales will help slow and eventually halt most wind erosion. The snow fences will also produce snow drifts providing additional moisture to grass seeding later into the growing season. It would be desirable to anchor straw bales as they could be blown away.

Compressor Operation Noise

Proposed by Applicants

Noise studies will be made at compressor stations to determine where special silencing equipment is needed.

Analysis

This step is essential to identify the type of noise suppression equipment needed. The results of such tests should be provided to the responsible agency with detailed maps that show sound sources, receiver reading locations, and orientation of buildings and other sound barriers.

Conclusion

There will be additional noise at four compressor stations resulting from the new line. The noise levels of compressor stations are not expected to exceed regulatory agency standards.

Dust Control

Proposed by Applicants

When loose soil creates excessive dust, the work area will be kept wet to minimize the dust.

Analysis

Wetting down construction areas to control dust is commonly used and generally is an effective process. The effectiveness of the measure, however, depends on getting equipment such as water tankers to the area to do the wetting down when needed.

Conclusion

Operating plans approved by agencies managing lands crossed by the right-of-way should include dust control requirements, but effectiveness will depend on proper administration and cooperation.

Disturbance of Nesting Birds

Proposed by Applicants

Construction will be timed to avoid peak wildlife nesting periods in areas designated major wildlife habitats whenever possible.

Analysis

As presented in Section 3.1.4.7, unique, sensitive, threatened, or endangered species may inhabit the vicinity of the present right-of-way. Especially sensitive to construction activities, including noise impacts such as blasting, are raptors such as Bald and Golden eagles, osprey, prairie and peregrine falcons, and spotted owls. A number of nests are identified within a mile of the right-of-way.

Conclusion

Recognizing the value and protective laws regarding a number of these species, the Applicants' proposal will be made a requirement of an approved operating plan.

Mitigation of Crop Losses

Proposed by Applicants

As far as possible, construction work will be scheduled to prevent major conflicts with the planting, growing, and harvesting season. Compensation for crop losses and other damage will be negotiated with individual owners.

Analysis

Planting, growing, and harvesting seasons on a number of crops can cover periods of up to 6 months of prime construction season. Contractors cannot readily be pulled off one segment of the 917 mile project and moved to a distant location to avoid crop disruption. Compensation payments negotiated with individual owners for their crop losses appear to be the basic means of mitigation that will be used.

Conclusion

Special excavation and backfill measures to save topsoils are needed to mitigate crop losses caused by soil disturbance.

River Crossings and Wildlife

Proposed by Applicants

In accordance with permits and governmental regulations, river crossings will be scheduled to minimize dangers to the stream flow, fish, waterfowl, and other wildlife and to avoid periods of high runoff and flooding.

Analysis

The Applicants state that where practical, stream crossings will be scheduled for summer months. This is the ideal time for such construction as rivers and streams are at a low point, and intermittent streams are usually dry. During this season, there is a general absence of migratory fish and spawning activity. Permits required for stream crossings by State fish and game agencies usually specify limits on seasons of operation to avoid spring and fall migration and spawning seasons of salmon and steelhead trout. In some of the smaller streams, construction will cause turbidity which will be lethal to some resident trout populations and any downstream migrating salmon and steelhead fingerlings in the immediate vicinity.

Conclusion

Compliance with agency's permits will mitigate damages considered dangerous to fish, stream flow, and wildlife to acceptable minimums.

Construction and Forest Fires

Proposed by Applicants

Construction in forested areas will be timed to avoid fire danger periods in accordance with governmental regulations.

Analysis

Laws enforced by State forestry departments require total shutdowns or the halting of construction operations in forest areas during extended periods of low humidity and dry conditions. These conditions, frequently encountered during summer afternoons in western forests, typically are compensated by moving working hours to start at first daylight shifts when humidity is higher (above 30 percent) and fire danger is lower. During extreme fire danger periods, a State forester may "close the woods" to travel, logging, and construction for periods up to several weeks.

Conclusion

Fire laws are strictly enforced. Infractions are subject to fines and/or criminal or civil prosecution if fires result.

Clearing of Right-of-Way

Proposed by Applicants

Clearing of trees and brush will be kept to the minimum required for the construction of the line. Trees will be cut as close to the ground as possible. Marketable timber in national forests will be harvested and set aside as directed by the Forest Service. On private lands, each situation is evaluated individually and a decision reached with the landowner. Brush, stumps, and slash will be disposed of either by burning or hauling away to designated areas. Material dumped into canyons, drainage ditches, and drains will be removed.

Analysis

Other considerations are that burning or hauling away of slash should be a last resort; scattering of small brush piles where fire hazard is not severe is desirable for maintaining small game and other wildlife cover; chipping of slash and its use for mulch in compacted soil areas is desirable from a watershed and soil restoration standpoint. On private lands, restoration decisions must be arrived at with each private owner.

Conclusion

These measures appear adequate and should be worked into an approved operating plan.

Topsoil

Proposed by Applicants

As per landowner/tenant or agency agreements, topsoil in selective areas will be stripped and stockpiled separately during grading. Following construction, the topsoil will be replaced to encourage regrowth which would reduce erosion. Cultivated land that has been compacted will be loosened by use of a ripper, disk, harrow, or other suitable equipment.

Analysis

The Applicants do not state how much topsoil is to be stripped and stockpiled, or indicate areas where topsoil is too thin for removal. Stockpiling of the A horizons should be specified. Even with careful stockpiling, there will be inevitable mixing of upper and lower soil horizons during backfilling. This will cause redistribution of nutrients to lower, inaccessible zones.

Conclusion

Restoration of natural fertility can take many years for soils to redevelop completely to full productivity. Ripping, disking, and harrowing will temporarily loosen compacted soils. The Applicants do not mention compaction of backfills which should be compacted to the density of surrounding undisturbed soils. Construction plans must include provisions for topsoil excavation, protection, and replacement over the trench.

Excess Excavated Material

Proposed by Applicants

Surplus rock will be set aside and redistributed on the right-of-way in small, irregular clusters rather than long, narrow berms, or it will be hauled away to predetermined disposal sites.

Analysis

Such materials can also be used for lining cross drainage ditches on the right-of-way, or used for riprapping at stream crossings rather than disposing of it and excavating new materials for these purposes.

Conclusion

This is a desirable mitigating practice in all but agricultural areas.

Revegetation Techniques

Proposed by Applicants

The right-of-way will be graded, reseeded, and fertilized where appropriate to retard erosion and restore its appearance over a period of time. Berms and breakers will also be used to retard erosion where necessary.

Analysis

Some soils (e.g., areas noted in the Columbia Plateau Province) are not readily suited to revegetation and will require primary use of mechanical stabilization. As the Applicants state, "Specific localized expertise will be required to help create the correct reseeding program for each varying type of environment." The Forest Service, Bureau of Land Managment, soil conservation agencies, and various fish and game agencies are cited as authorities to be contacted by the Applicants. It is important that undesirable exotic species not be introduced. This can be especially critical on sites occupied by rare and endangered plants and in agricultural areas. Also, a seeding mix should not be composed of all annuals for quick establishment, but only first year protection.

Conclusion

The Applicants' proposal is a necessary mitigating measure critical to soil erosion, esthetics, wildlife, and air pollution. In addition, the Applicants should identify the special methods to be employed in areas where revegetation cannot be accomplished within one season.

Restoration of Cultural Features

Proposed by Applicants

Fences, roads, irrigation, and drainage ditches will be left in good repair following construction.

Analysis

These are standard operating procedures subject to agreement between the Applicants and each landowner involved.

Conclusion

Mitigation of damages to fences, roads, etc., must be included in construction plans.

Streambank Stabilization

Proposed by Applicants

Waterways will be left free of obstructions. Graded construction ramps at river crossings will be removed and channel banks and levees backfilled to original grades and fully compacted where necessary to prevent erosion. When conditions indicate a high risk of bank erosion, riprapping, breakers, cutoff walls or rock facing will be placed on channel banks and levees to restore them to their original grade as indicated by good construction practice or required by government regulations.

Analysis

Agencies involved in approving bank stabilization measures at stream and river crossings include State fish and game departments, the Corps of Engineers on navigable rivers, and all owners of land on which the crossings occur. Vegetative seedings or plantings will also be desirable in addition to rock facing or riprapping on many crossings, but cannot be considered substitutes for heavy mechanical stabilization measures that withstand peak flows.

Conclusion

This proposed mitigation appears satisfactory and desirable, if carried out as outlined.

Enhancement

Landscaping at Compressor Stations

Proposed by Applicants

Compressor stations may be landscaped with planting and earth berms where sites are visible to the public from heavily traveled roads.

Analysis

Landscaping, planting, use of paints in harmony with local environment, use of nonreflective materials, and design of facilities will be required in a construction plan approved by the Department of the Interior on all Federally controlled lands.

Conclusion

This mitigating practice will adequately provide for good esthetics around compressor stations.

Vegetative Buffers

Proposed by Applicants

In accordance with agreements with various owners and agencies, trees will be planted in the pipeline right-of-way at road crossings to screen views. Natural vegetation will be allowed to grow.

Analysis

Trees planted in adequate width screens (e.g., strips 100 feet or wider) at right-of-way crossings of major roads should effectively block views of the tunnel effect caused by the pipeline right-of-way through forested areas. Trees will not be allowed to grow directly over the pipeline trench due to potential damage to the coating of the pipeline by tree roots.

Trees cannot be planted to screen views of pipeline scars in arid areas where only brush vegetation will grow. Planting of native shrub species can be used in such locations.

Conclusion

Such techniques will help mitigate, adverse esthetic impacts.

Wildlife Habitat Restoration

Proposed by Applicants

As required by agencies and landowners, a reseeding and fertilization program to control erosion and protect and enhance wildlife habitat will be provided in those areas of the pipeline where wind and/or water erosion is a problem.

Analysis

Caution must be exercised not to overconcentrate favorable forage species where these are scarce in surrounding areas. This can result in attracting heavy wildlife concentrations, with overbrowsing that leads to loss of soil holding cover, and create driving hazards on highways which the pipeline will parallel.

Conclusion

This is a desirable enhancement measure for wildlife habitat if plant species with necessary erosion control features are also included.

Noise Abatement at Stations

Proposed by Applicants

Noise suppression devices will be provided at compressor stations as needed. Silencers have already been installed on the turbines and blowdown stacks at several stations. Because noise regulations are becoming strict, sophisticated equipment is now available and will be installed on the new units. In most instances, noise levels produced by the new equipment will be less than existing levels.

Analysis

Without noise suppression devices, the Applicants expect continuous noise levels at compressor stations 13 and 14 (the only stations planned for expansion near residences). The Applicants indicate some form of noise silencers are installed at these stations.

Conclusion

The proposed mitigation measure is adequate so long as there is compliance with State regulations.

4.1.4.3 Safety and Emergency Measures to be Implemented During Construction and Operation

Proposed Safety and Emergency Measures

The Applicants have proposed that the pipeline and auxiliary facilities will be designed and constructed in accordance with the Department of Transportation (DOT) Minimum Federal Safety Standards (Part 192), Occupational Safety and Health Act (OSHA), Part 1910 and Part 1926, and the California Public Utilities Commission (CPUC) General Order 112-C. The Applicants should provide a detailed health and safety plan for both the construction and operation phases, as part of the final system design.

Cathodic Protection

Proposed by Applicants

Pipeline facilities will be placed under cathodic protection to eliminate the possibility of leakage due to corrosion.

Analysis

The proposed pipeline will cross under a number of large electrical power transmission lines which produce electromagnetic fields capable of inducing potentials on the pipeline that will result in accelerated corrosion and potential leaks unless the pipeline is provided proper cathodic protection. The Applicants state that cathodic protection test leads will be installed every 1 to 2 miles along the line and fully tested each calendar year.

Conclusion

The above procedures will help insure that the proposed pipeline will be installed and operated in a safe manner similar to the existing parallel line.

Operating Pressure Strength Test

Proposed by Applicants

All systems will be given a pressure strength test to insure the integrity of the pipeline and establish a maximum allowable operating pressure.

Analysis

Testing for pressure strength prior to operation is essential for safe operation of high volume, high pressure gas pipelines.

Conclusion

The procedure is essential to startup operations to mitigate safety hazards.

Pipeline Markers

Proposed by Applicants

The right-of-way will be marked at intervals to warn contractors and the general public of the presence of the pipeline.

Analysis

Operators will be required to install signs and markers wherever necessary to reduce the possibility of pipeline damage. The Applicants have stated that pipeline markers will be installed over the pipeline at intervals of about 1 mile and at river crossings. In addition, Federal and State regulations require fencing and signing of all major aboveground facilities such as compressor stations, microwave towers, metering stations, and mainline block valves.

Conclusion

Applicants' mitigative proposal appears adequate.

Pipeline Surveillance

Proposed by Applicants

Aerial and ground patrols will look for construction in the pipeline area which might constitute a hazard and for dead vegetation that might indicate a leak in the line. Flame ionization surveys and combustible gas surveys will be made by periodic patrols looking for leaks.

Analysis

The line patrolling requirements leave frequency of patrol open and dependent on severity of conditions likely to cause failure or leakage.

Conclusion

On segments where such conditions are anticipated, 3-month maximum inspection intervals are specified. But additional patrols are warranted during the startup period.

Public and Livestock Safety

Proposed by Applicants

Fences and barricades will be placed around construction areas and open trenches where a possible hazard to the public or local livestock exists.

Analysis

For short periods of time during construction, open trenches will be a hazard to children, livestock, and wildlife. The best mitigation for this hazard is the earliest backfill possible, yet certain inspections and safety tests must first be completed.

Conclusion

Barricades, signs, signals, and flags are adequate protection devices.

Risk from Other Construction

Proposed by Applicants

The companies will continue the policy of "call before you dig" so that company personnel can assist contractors working in the area in determining the exact location of the line.

Analysis

The "call before you dig" policy is standard operational procedure with utility companies.

Conclusion

The procedure mitigates potential damage to the pipeline.

River Crossing Pipeline Placement

Proposed by Applicants

The pipeline will be designed and weighted to provide negative buoyancy at river and stream crossings. The pipeline will also be weighted in areas of high groundwater.

Analysis

Concrete weighting will insure negative buoyancy at water crossings and in areas of high ground water. It will not, however, prevent some scour of loose material backfilled in underwater trenches. It will prevent the pipe from floating upward during scouring and being caught in strong currents carrying gravels and debris which could result in rupture of the line. The Applicants indicate trench depths would generally vary from 8 to 16 feet in stream and river crossings, depending on streambed and scour and flow characteristics of the stream. This technique is designed to get below the ultimate scourline of the creek to avoid pipeline damages under even the heaviest water flows and scouring conditions.

Conclusion

Detailed site construction plans will mitigate against potential damage of the pipeline at stream crossings.

Fire Hazard Precautions

Construction Sites

Proposed by Applicants

Precautions such as those required by the Forest Service will be used to reduce fire hazards from all internal combustion engines. Other requirements may include tankers and pumpers on construction sites.

Analysis

State forest laws and rules administered by the Forest Service and the Bureau of Land Management call for certain minimum fire prevention and suppression equipment. Permits and contracts require the filing and subsequent approval of fire prevention and suppression plans in advance of each fire season.

Conclusion

Compliance with these requirements reduces the causes of fires.

Compressor Stations

Proposed by Applicants

Fire and gas detectors, over-pressure protection, and other safety devices are and will continue to be incorporated into all compressor station systems. Pressure limiting and pressure relief facilities will be installed on the pipeline.

Analysis

Fire and explosion hazards are of greatest concern at compressor stations. Compressor stations must be isolated from other buildings, constructed of noncombustible materials, wired to code, and fenced. Compressor stations must have emergency shutdown equipment capable of

blocking gas out of the station and blowing down station piping to a nonhazardous location. Each compressor station is required to have pressure relief devices sensitive enough to keep operating pressures from exceeding maximum allowable pressures by more than 10 percent. Fire protection facilities are also required for each compressor station, but are not described in detail in the regulations.

While all but a few of the compressor stations existing or planned for the line are unmanned, they are under continual observation and surveillance by telemetry systems. Surveillance is conducted automatically by detection equipment and computer interrogation and manually by operating personnel headquartered at 24-hour attended facilities. Equipment malfunction can be detected and corrective action initiated from the control headquarters.

Conclusion

Since the same compressor stations used on the existing line will be used for the proposed line, and there have been no fires or explosions, the proposal seems adequate.

4.1.4.4 Additional Measures Which Could Be Used to Further Reduce Environmental Impacts

The following mitigation or environmental control actions were not proposed by the Applicant, but if applied, could significantly reduce adverse environmental effects.

Additional Environmental Mitigation Measures

The following measures are listed in the sequence of the impacts listed in Section 3.1.4.

Climate--No additional measures were considered.

Topography--No additional measures were considered.

Geology--No additional measures were considered.

Soils--Proper compaction of fills and ditches to the same density of surrounding undisturbed soils would hasten restoration of normal surface drainage characteristics. Selected material should be used when preparing the open trench prior to bedding of the pipe.

Water Resources--The use of chemical, self-contained toilets in all construction operations other than preliminary route surveys would prevent contamination.

Contaminants such as pesticides, herbicides, waste oils, cleaners, and solvents should be collected and hauled to waste disposal sites rather than buried or discharged within the right-of-way or operating facility areas.

Hydrostatic test water should be inspected and monitored, and restored an acceptable level in accordance with local and EPA discharge regulations

prior to discharge into waterways. Water that does not meet standards for direct discharge should be diverted into settling ponds.

Where settling ponds are needed for test water discharges, construction borrow pits could be used rather than making additional excavations.

Rates of test water intake and discharge (in gallons or cubic meters per second), quality, specific intake and release locations, and groundwater level should be submitted as a part of the overall construction operating plan.

Groundwater should be protected from pollution at stream crossings by:

1) Policing the construction site against accumulated waste products.

2) Reducing the use of machinery in water courses to absolute minimums.

3) Diverting or removing water from the proposed pipeline excavation by pumping from the excavation as long as it remains open.

Vegetation--Native species of grasses, shrubs, or trees should be replanted. Introduced species should be approved or recommended by local authorities with the concurrence of landowners.

Only that portion of right-of-way needed for excavation and movement of equipment should be cleared and grubbed. Wherever possible, cut vegetation close to ground, leaving root systems intact for soil holding and early resprouting. The preferred method of disposal is chipping and spreading of treetops and brush.

Wildlife--Applicants should be required to make a predesign route survey of the entire pipeline right-of-way by qualified biologists. The survey report should identify each stream crossing that has anadromous fish spawning areas within 1 mile downstream of proposed crossings. A map should be developed that shows the location of each existing raptor nest within the right-of-way and approximate locations of any rare or endangered raptor nests within 1 mile of the right-of-way. The survey reports should describe any location evidence of other rare or endangered species along the right-of-way. Such a report should be used in developing the scheduling and operating plan for construction which is also to be approved.

Wherever possible, raptor nest trees in the right-of-way should be left uncut.

Wildlife browse, feed, and cover species should be included in seeding mixtures used for soil holding purposes and for maintaining erosion effectiveness.

Open ditches ahead of pipe laying crews and delays in backfilling should be kept to a minimum to avoid entrapment of animals.

Ecological Considerations--No additional measures were considered.

Economic Factors--No additional measures were considered.

Sociological Factors--No additional measures were considered.

Land Use--No additional measures were considered.

Archeological, Historic, and Other Unique Values--The Applicant must comply with procedures to nominate sites for the National Register of Historic Places, procedures under Public Law 93-291, Section 106 of the Historic Preservation Act of 1966, Executive Order 11593 and 36 Code of Federal Regulations, Part 800. All such compliance should be in coordination with the State Historic Preservation Officer and with all Federal, State, and local agencies and organizations.

Recreational and Esthetic Resources--Where the pipeline right-of-way passes within 400 feet of Lava Caves State Park, blasting could endanger the safety of visitors viewing these Lava Tubes. Therefore, blasting should be done under State of Oregon direction.

Edges of right-of-way should be "feathered" to avoid "tunnel" effects. This involves leaving vegetation within the right-of-way clearing limits when feasible or by tying into existing natural openings.

In addition to requiring that native species be used for right-of-way revegetation, species should be chosen to provide harmony in size and texture with surrounding vegetation. Where possible, clearing should be limited to cutting stems close to the ground rather than grubbing. This will assure some native regrowth and avoid the color and texture changes of exposed soil.

Borrow pits should be filled or contoured along natural lines to resemble ponds and natural depressions rather than rectangular pits.

Air Quality--Open burning of dangerous materials such as chemicals, solvents, pesticides, oil, asphalt materials, plastic, or explosives should not be allowed.

Open burning should be conducted as far from populous areas as possible, and in compliance with State and local fire and smoke control regulations.

No open burning should be done in narrow river bottoms or areas of confining geographical features (such as the Moyie, Spokane, Kootenai, and Pit River Valleys).

When open burning is necessary, burning should be done during daylight hours and when atmospheric conditions are conducive to rapid dispersion of pollutants.

Carbon monoxide and hydrocarbons emissions can be reduced by tuning and maintenance of vehicle engines and steady operation of compressor engines to maintain optimum combustion efficiency.

If air pollution alerts are given by State, regional, or county authorities, all mobile equipment should be shut down. Fixed installations such as compressor stations should be able to continue operations unless an extremely serious condition causes authorities to issue a shutdown order.

Environmental Noise--The primary noise impact is sound emitted by engine powered heavy equipment, thus the primary mitigating measure should be mufflers. Since the U.S. Environmental Protection Agency has recently

adopted noise standards for trucks used in interstate commerce, these standards should be applied to all offsite diesel engine powered trucks to be applied by specification with the construction contractors. Pipe hauling should be restricted to daylight hours in the more populous areas. Air compressors should meet U.S Environmental Protection Agency standards. Annoyance from construction noise is greatest during the evening hours. In order to mitigate the disturbance, construction should be avoided between 9 p.m. and 6 a.m.

Since blasting results in environmental noise of serious nature and ground vibration of large magnitude, control of explosives used is important. An explosives management plan is to be submitted to the cognizant agency when detailed knowledge of the need for and the potential adverse effects of any blasting is known. The plan should set forth policy and should include blasting techniques; blasting locations; methods for avoiding rockfalls and landslides; and damage to structures, people, and wildlife, particularly aquatic. Minimizing charge size, and blasting only during the day should be required.

Sound from the compressor stations and venting would be the only environmental noise problem during the normal operational phase. Sixteen compressor stations are already in use. Four of these will be increased in horsepower which will result in an increase in the number of people impacted by an L_{dn} greater than 55 dB and in the number of people highly annoyed. Both of these impacts are small and can probably be completely mitigated by treating the turbine intakes and exhausts with additional silencing equipment.

All stations in Washington and Oregon should be designed to meet the night standards of the States of Oregon and Washington, respectively. The trend in State noise control legislation has been to regulate stationary noise sources and eventually all stations will have to meet standards similar to those of Oregon. Thus, it would be more economic to implement the noise control devices during the design phase; or at least make allowance for future installation of muffling equipment. The design can be implemented in Oregon, and Washington, and the necessary noise control equipment can be added later at other stations.

It is important to put the exhausts and fans on the far side of the station buildings away from the nearest residential area.

Gas blowdown from a high pressure line would create a very intense noise source (see Section 3.1.4.15) that could be heard for miles. The vents should be equipped with mufflers that will not permit the gas to pass straight through. Minimum reduction should be 30dB; the specific design, however, must depend on the proximity of people with regard to the State of Oregon regulations.

Hazards--The applicant should supply a plan for shutdown and venting specifying proposed criteria for blowdown valve stacks near electric transmission lines (see Section 1.1.4.7).

Slide areas along the pipeline route should be identified, and heavy blasting utilizing simultaneous detonation of many charges should be avoided when traversing such areas.

Minor Alignment Changes

It appears preferable to move the Tehama Colusa Canal overhead crossing approximately 75 feet upstream, placing it parallel to the existing crossing. A U.S. Fish and Wildlife Service spawning gravel baffle cleaner must pass under the current suspended pipeline crossing and this clearance specification would assure future ease of this operation. Final selection of the crossing should be with the U.S. Fish and Wildlife Service approval.

Geotechnical Considerations

Except for negative bouyancy specifications for stream and river crossings, there is little information provided by the Applicants to show how external environmental stresses on the pipeline, including mass soil movement from heaving, earthquake occurrence, and soil-chemical reactions, have been specifically evaluated in pipeline design.

Construction of the proposed pipeline would have virtually no effect on the surrounding geologic environment if proper construction and restoration procedures are observed. However, the intensity of the impact of the geologic environment on the proposed facility varies. It is related to the potential severity of geologic activity in a given area. Impacts include loss of pipe support, pipeline breakage or rupture, along with possible damage to compressor and measuring stations, airfields, and roads. The most significant impact would involve pipeline rupture and the resultant possible damage by fire or explosion.

To mitigate these impacts, first the geologic hazards must be accurately identified (see Section 2.1.4.3, Geologic Hazards). This is particularly true in the case of active faults. Once identified, each geologic hazard must be evaluated individually, and the maximum possible intensity generated by the particular geologic feature established. Engineering design of the pipeline in the vicinity of geologic hazards should then take into account the maximum expected intensity that could be generated by that particular hazard. If it is not possible to design for the maximum expectable intensity predicted for a particular hazard, the pipeline should be rerouted around that hazard.

Mitigations of lesser potential importance are as follows: 1) Particular attention should be taken to restore the local ground surface along the proposed route to its pre-trench configuration so that surface drainage will not be disrupted; 2) Excess spoils should not be piled in drainages in order to avoid local ponding or diversion of small or intermittent streams; 3) Talus cones of basaltic debris along the Snake River Valley should be avoided because of their instability; 4) Terrain scars should be minimized by careful restoration along the trench and by using existing borrow pits for needed construction materials; 5) Special attention should be taken to minimize scarring of the youngest volcanic flows of the Northwest Rift Zone of Newberry Crater in Oregon, as these are among the finest examples of young basalt flows in the United States.

Additional Measures

The following additional measures, if taken, will aid in mitigating the proposed action and reduce the probability of pipeline damage and resulting environmental impacts.

1) The effect of the proposed pipeline on local ground temperatures for all conditions of operation and the effect of this ground temperature on drainage control problems should be analyzed and mitigated, if possible.

2) All unstable slopes and erosion-sensitive rights-of-way in segments and areas subject to subsidence should be identified. Additional measures should include the identification of soil data and all unstable slopes along the pipeline route, and an evaluation of the potential hazard to pipeline integrity using estimates of pipe external loads and pipe movement under the worst condition.

3) Criteria should be developed which would allow areas with a high potential for accelerated erosion to be defined on a detailed basis and in a manner suitable for portrayal on construction drawings. These criteria should provide methods for the calculation of required quantities of backfill, mound breaks, culverts, ditch plugs, borrow, and other control and restoration measures. Criteria should consider soil type, including thermal state and moisture content, topography, climate, hydrology, construction mode, and grading geometry. The various specific control measures should be formalized to the point of standardization such that they can be specified to apply, with appropriate modifications for local conditions, to any section of the pipeline. Specific criteria to restore riverbeds where these have been breached for crossing and to protect them from excessive erosion should be provided.

4) Allowable loads criteria for each landslide bench traversed by the proposed pipeline with supporting analysis should be developed. Precautions to prevent landslides and a monitoring program to detect ground movement should be included. Observation wells should be drilled into a landslide area to: a) provide data on internal drainage; b) monitor groundwater level and pore pressure; c) provide internal drainage from the inside of the slide mass; and d) provide data on the source of any subsequent land movement.

5) Detailed information should be provided on the 9 miles of slope in excess of 25 percent, giving for individual slopes the overall slope angle, angle of the steepest portion of the slope, and the angle between the pipeline and slope contours. This information should be used as a basis for determining stability control measures.

6) The soils along the pipeline route should be examined, identifying those areas susceptible to seismic liquefaction and strong ground motion, and stating what measures will be adopted should these conditions be found. Soils in the Sacramento Delta crossed by the pipeline would be of particular interest.

7) The location of active faults and epicenters from most recent published sources should be verified. Prior to and during pipeline construction, additional active faults should be identified and reported. If active faults are crossed by the pipeline, designs should be changed to minimize risk of breakage.

8) Criteria should be developed for special precautions to be taken when in the proximity of mines, oil wells, railroads, highways, transmission lines, pipelines, or other private or public facilities that constitute a hazard to the pipeline.

9) Criteria should be established for inspection of trenches and the properties and compaction of bedding materials.

Additional Monitoring Measures

Air quality impacts of turbine engines powering compressor stations should be monitored at all compressor stations. NO_x and CO emissions should be monitored on a regular monthly basis using mobile equipment to take readings at 1-mile intervals from the source to a point 10 miles downwind of the source. Copies of monitoring logs should be provided the State air resource boards and/or regional air quality officials. The Applicants may make arrangements by cooperative agreements to have such agencies carry out the testing.

5 ADVERSE ENVIRONMENTAL EFFECTS WHICH CANNOT BE AVOIDED SHOULD THE PROPOSAL BE IMPLEMENTED

5.1 ARCTIC GAS PIPELINE PROJECT

5.1.4 San Francisco Pipeline

The following discussion summarizes the adverse effects that cannot be mitigated if the proposal is implemented. It assumes that all of the mitigating measures discussed in Section 4.1.4 are applied. It should be pointed out that the adverse impacts of the existing pipeline on the environment have already been sustained, and that the proposed pipeline will involve dedicating some additional 960 acres as permanent right-of-way along an already impacted right-of-way. Approximately 1,150 acres not previously disturbed will be impacted mostly as temporary working areas during construction.

5.1.4.1 Climate

The proposed project will have no significant impact on climate. Precipitation and wind factors influencing erosion impacts are discussed in Section 5.1.4.4.

5.1.4.2 Topography

The proposed project will have no major effects on topography because of the relatively minor amount of earth moving involved compared to the general mountainous topography of the surrounding area. Backfilling the trench and spreading the remaining soil and earth over the right-of-way will mitigate any major adverse impacts on topography.

Unavoidable impacts affecting topography that will occur, include (a) erosion by surface runoff, (b) scour by streams, (c) changes in the surface form, (d) longitudinal and lateral migration of meanders, (e) changes in surface drainage, (f) erosion by wind, (g) sedimentation by runoff and streams, and (h) temporary stock piling of excess soils.

5.1.4.3 Geology

The proposed project will produce no significant adverse impact on geological structures. Geological conditions near the proposed route pose potentials for impacts but the 14-year history of operating the adjacent parallel pipeline provides no incidents of adverse effects to geological structures. The proposed pipeline is to be rerouted through the John Day River canyon to avoid the area considered most likely to have an effect on geology.

Adverse impacts which cannot be neutralized by mitigating measures include:

1) fracturing of bedrock during trenching,

2) consumption of minor amounts of geologic resources, and

3) limitations in production of geologic resources.

5.1.4.4 Soils

With full application of all mitigating measures prescribed in 4.1.4.4, unavoidable adverse soil impacts will result largely from reworking and compacting of soils within the right-of-way. Loss of a minor amount of soil productivity is unavoidable due to the remixing of topsoils, removal and mixing of soil nutrients, and reduction in water holding capacity of the soil.

Some wind and water erosion will occur especially from construction activities. The sandy soils in the Columbia Basin are highly erodible by winds; to a lesser degree, the soils of the Central Valley, California, and from the Snake River to Bend, Oregon, will be lost to wind erosion. Likewise some water erosion of soils cannot be avoided during construction and rainy periods. Both wind and water erosion will revert to near-preconstruction levels if proper mitigating measures are taken.

5.1.4.5 Water Resources

Unavoidable adverse impacts can be expected during construction of the pipeline at the 26 crossings of 18 major streams in channel equilibrium, streambank disturbance, diverted flow, increased turbidity, suspended sediment and bedload transport, increased soil erosion, increased surface water temperatures, lowered dissolved oxygen concentrations, interrupted stream flows, water quality degradation, and loss of stream biota. The more significant unmitigated effects will involve channel equilibrium, increased sedimentation and turbidity, and stream biota loss.

Channel erosion and bank disturbance of stream channels during construction, regardless of the crossing method, will increase sedimentation and decrease water quality. Most effects will represent only a short-term disturbance of channel equilibrium (e.g., the local scour and fill associated with subaqueous trenching) and will disappear with time. Both methodology and timing of construction can reduce these effects, but not eliminate them.

Changes in stream position and pattern caused by ramps, supports, and other structures may divert flow during construction. New downstream patterns of erosion-deposition may be triggered in meandering streams.

Turbidity, suspended-sediment, and bedload transport will increase during construction. Both stream biota and esthetics will be affected. Where the bed material is fine grained (with a high clay and silt content) but sufficiently heterogeneous to keep the cohesive properties of the clay-size fraction from forming a stable bottom (e.g., the Sacramento River crossing site), a large volume of material may need to be excavated, especially if trenching is done at a high or intermediate flow. Coarse grades of sediment, sand-size and above, will be transported comparatively short distances. There is no way to completely mitigate this impact.

The potential for low-level, long-term turbidity and sediment transport may be indirectly increased by the access provided to off-road vehicles along the cleared pipeline corridor. This potential will be most pronounced in forested areas of Idaho, Washington, northern Oregon, and the crossing of the Cascade Range in northern California.

Increased erosion potential will result from the clearing of right-of-way areas containing highly erodible soils. Mitigation measures can reduce but not eliminate this impact.

Minor increases in surface water temperature will be noticed after the removal of shade vegetation at stream crossings. This impact will be most noticeable in the heavily forested parts of the route.

Limited temporary depressions in dissolved oxygen concentration, additions of toxic substances from leakage of fuel spills, cleaning agents, other wastes, and bacterial contamination can occur if there are waste discharges into flowing waters.

There will be temporary interruptions of flow in streams and reduction of local water sources resulting from withdrawals of water for hydrostatic testing. Filtration may impinge organisms. Again, mitigation measures can reduce but not completely eliminate these adverse impacts.

Adverse effects on stream biota will depend upon timing of construction. Organisms will be more severely affected by turbidity and sediment deposition if construction occurs in the spring or fall. Ideally, it should be possible to keep the impacts on biota at a minimum by construction during winter and summer months. From a practical standpoint, however, ideal timing of construction across all streams and rivers will not be possible, and as a consequence, adverse impacts of construction on stream biota will occur. Detailed quantifications are not available and impacts would be variable.

Use of only the Applicants' proposed water resource mitigation measures is likely to permit increased residual adverse effects on water resources from two main sources, namely, hydrostatic testing (water intakes and discharges) and onsite disposal of water polluting wastes.

The Applicants do not limit the intake and discharge of hydrostatic test water to major rivers and waterways, but prefer to have the option to obtain water from small streams and underground sources, and discharge water into small stream and dry channels. Additional measures as discussed in Section 4.1.4 point out the need for a hydrostatic testing plan which would: 1) describe the source and volume of all water to be used for each test segment of the pipeline, and 2) specify the discharge points and the manner in which water from each segment will be disposed, including the amount and rate of discharge and the first stream which the discharged water will enter.

5.1.4.6 Vegetation

Except for some 1,150 acres, all of the right-of-way was originally cleared in 1961 during construction of the existing pipeline. The original right-of-way area has since been revegetated almost in its entirety by both artificial and natural means. Very little additional clearing will be required for compressor stations and roads, as the existing facilities will be used by the proposed pipeline.

Adverse impacts to vegetation falls into two categories--natural plant communities and cropland. The project will impact from 4,800 to 5,100 acres of cropland; this is mostly an economic impact rather than environmental. Cropland will be out of production for up to 2 years.

Nearly 400 additional acres of commercial forest land will be taken out of production for the life of the project.

Construction impacts will be visible for a long time in forest and sagebrush areas. Visual impacts of the pipeline will be short-lived on agricultural and riparian lands.

Approximately 43 acres of aquatic vegetation will be disturbed by the proposed 26 river crossingss. Sedimentation will temporarily affect growth rates of aquatic vegetation. Aquatic vegetation will generally return to its preconstruction state within 2 years after disturbance by construction of the pipeline.

Riparian vegetation that is cleared will revegetate rapidly.

5.1.4.7 Wildlife

Unavoidable impacts on wildlife will result almost entirely from the construction phase of the proposed project. Operation and maintenance of the existing pipeline has had no significant adverse impacts on wildlife populations.

The proposed pipeline traverses 137 miles of critical deer winter range. Clearing of vegetation will probably result in a 3-year loss of winter range on the right-of-way. Two deer migration routes will be temporarily interrupted by the open trench during pipelaying. Some animals will probably be caught in the pipeline trench. The small populations of martens, fishers, and wolverines, if affected, may take up to three generations to repopulate the right-of-way vicinity. Upland game birds will undergo the same population decrease as deer in the right-of-way vicinity, resulting in a temporary 1- to 2-year reduction of 5- to 10-percent of their population. There may be some upland game bird population decreases lasting for a longer period of time in areas near Redmond, Oregon, and Lost River to Tionesta, California.

Birds of prey will be the species most adversely affected by new pipeline construction activities during their nesting seasons. Their nests will probably be abandoned for at least 1 year, causing a loss of a year's brood. Therefore a population decline in such species will result. Expecially sensitive areas are the Prairie falcon habitat near the Snake River and the four active bald eagle nests known to exist within 2.5 miles of the route near Lake Britton.

Resident fish (trout in streams, sunfish, and other warm water fish in warmer rivers) will suffer some loss of population at the immediate crossing areas due to underwater blasting that causes shock, turbidity and lower dissolved oxygen content.

If it becomes necessary to cross an anadromous fishery stream during a spawning season, sediment could destroy half to almost all of the new year class reproduction. Impacts on fisheries will be limited to 1 year if revegetative and watershed control mitigation measures are fully implemented.

Undoubtedly, some unknown numbers of wildlife living on the right-of-way will be lost during construction. However, there is no information available that indicates any one species will be seriously impacted.

The sound from blowdowns during operation of the pipeline will temporarily disturb wildlife.

5.1.4.8 Ecological Considerations

Unavoidable ecological impacts are incorporated into the discussions of specific resource impacts.

5.1.4.9 and 10 Economic and Sociological Factors

Construction Phase

Certain of the adverse impacts upon people and community structures identified in Section 3.1.4.9 will unavoidably occur if the pipeline is constructed. The degree of impact will vary from community to community depending upon the number of construction workers and their families residing in each community, how long they stay, the size of the community, and services available. The variables are too imprecisely known to predict degree and location of economic and social impacts which result from temporary population increases during pipeline construction. However, these effects will be neither large nor persistent. Sociological impacts could be expected to be most severe in communities of central Oregon and northern California if construction occurs during the summer tourist season.

Unavoidable sociological impacts on small communities could include the following:

1) over-crowding of transient housing,

2) insufficient availability of tourist accommodations,

3) over-use of trailer and camping facilities,

4) unauthorized camping,

5) demands upon services (e.g., recreation, medical, dental),

6) demands upon water, sewer facilities and possibly schools in excess of capacity,

7) problems related to public safety,

8) stress among the resident population and tension between residents and non-residents,

9) possible price increases for some goods and services, and

10) overloading of solid and liquid waste disposal facilities.

Compensation paid by the Applicants for agricultural loss may indemnify the landowner. However, the decrease in crop production will be noticeable for several years after construction. Loss of timber production due to right-of-way clearing represents a negligible percent of the total annual harvest in the forested areas. Consequently no lumber price or supply changes will result from this loss.

Operation Phase

No significant adverse economic or social impacts are expected as a result of operating the proposed pipeline.

Increased revenue from property taxes will be realized by those counties traversed by the proposed pipeline.

5.1.4.11 Land Use

Construction of the pipeline will impact approximately 1,150 acres of lands that were not previously impacted. Of this total, some 400 acres are considered commercial forest lands -- mostly U.S. National Forest lands. These 400 acres will be impacted for the life of the project.

Approximately 4,800 to 5,100 acres of agricultural lands on the existing right-of-way will be reimpacted. Agricultural production will be disrupted for 1 or 2 growing seasons. There will be very minor reductions in future agricultural production since these lands were impacted by the original pipeline.

The remaining 750 acres of previously unimpacted lands are mostly used for grazing, watershed, and wildlife purposes. Construction will remove these lands from production for approximately 2 years although in the more arid areas full production will be slightly reduced for the life of the project.

There will be limitations on urban expansion. This restriction is considered very minor because most of the right-of-way is across rural private lands. For the most part this 100-foot wide right-of-way will not be widened. Urban areas close to the existing pipeline include Sandpoint, Idaho; Spokane, Washington; Bend, Oregon; Burney, Red Buff, and Winters, California.

Highway and road traffic will increase during the construction period. Road surfaces will receive heavier use than normal, thereby requiring increased maintenance.

There appears to be a conflict between pipeline construction and Wild and Scenic River Classifications of three major rivers. However, the addition of another pipeline along an existing pipeline should not be the determining factor in such classifications. The John Day River crossing has been located so as to have the least adverse visual impact.

5.1.4.12 Archeological, Historic, and Other Unique Values

Even though conscientious surveys are carried out, there may be an unavoidable loss of archeological values. The probability of such loss is negligible, because the proposed pipeline parallels an existing line from 20 to 30 feet away throughout most of the route. All known archeological sites on the right-of-way have been studied. No loss of historic values is expected as a result of construction of the pipeline.

5.1.4.13 Recreational and Esthetic Resources

During the construction period, there will be temporary unavoidable disruption and inconveniences to people using the public lands and the 17 recreation sites located within a mile of the pipeline. The degree of disruptions will depend on the season of construction.

The removal of vegetation and other construction activities will displace some wildlife species thereby reducing hunter success and wildlife observation opportunities near the pipeline.

Hunting and fishing in aquatic areas will be adversely affected during the construction period. The level of short-term adverse effects will vary from medium to low depending upon the noise level and the disturbance of the

riverbed. High noise levels will be experienced during the construction period at recreational areas and residences within one-half mile of the pipeline corridor. In addition to the noise, dust caused by construction and service vehicles could also affect the use of some recreation sites.

Construction at river crossings will leave scars in the landscape which will lower the quality of the recreation experience for river boaters and sightseers along the river routes. During the construction period, there may be unavoidable temporary disruption in the freedom of movement by the boaters and sightseers. This short-term effect will not be critical.

The esthetic impacts which will persist throughout or beyond the life of the project are:

1) strong lines and changes in color and texture due to the presence of the right-of-way through heavy timbered areas and desert areas, and

2) the introduction of forms, lines, colors, and textures by the installation of the pipe, and blowdown valves.

All of the above impacts already exist along the entire right-of-way except at the new John Day River crossing. Daytime blasting will present a noise nuisance to recreationists.

5.1.4.14 Air Quality

The most serious air quality impact to be expected during construction is the probable movement of dust in the Columbia Basin where soils are of silty or loess type. Clearing of the right-of-way and actual pipeline construction will result in soil disturbance and attendant dust clouds. Some dust problems can also be expected from heavy use of access roads during construction because wetting of the ground cannot completely mitigate the problem.

Occasionally, concentrations of vehicles, combined with quiescent atmospheric conditions and confining topography, will result in high levels of engine exhausts and dust particles, temporarily exceeding national and state standards in localized areas.

During pipeline operations, there will be two sources of impact that cannot be avoided:

1) exhaust gases from compressor stations, and

2) venting of gas (deliberate or automatic).

Accidental pipe rupture, if it occurs, will impact air quality. Compressor exhaust will be released during the lifetime of the project but the concentrations will be low.

5.1.4.15 Environmental Noise

Despite all efforts a pipeline cannot be quietly installed.

Even if trucks and construction equipment meet the EPA regulations, they will still produce sound levels between 86 and 90 dBA at 50 feet. Construction equipment fitted with mufflers will still produce high sound levels in the vicinity of the construction site, ranging from 76 to 101 dBA.

Operation and maintenance noise from compressor stations, and annual blowdowns, cause no serious nuisance, unless blowdowns are made near recreation areas during recreation seasons.

5.1.4.16 Hazards From Pipe Failure

Hazards in gas pipeline construction and subsequent operation are a function of risk which cannot be predicted accurately. The Applicants will follow all OSHA and Pipeline Safety Act Regulations.

6 RELATIONSHIP BETWEEN LOCAL SHORT-TERM USE OF THE ENVIRONMENT AND LONG-TERM PRODUCTIVITY

6.1 ARCTIC GAS PIPELINE PROJECT

6.1.4 San Francisco Pipeline

6.1.4.1 Introduction

The objective of this section is to analyze time-related resource tradeoffs that would result from construction of the pipeline. The short-term impacts are evaluated in terms of their relationship to long-term productivity of the environment. For most of the resources or values discussed in this section, short-term is that period during which the pipeline will be constructed and operated. Long-term is an indeterminate time period related to environmental quality for future generations, generally after project salvage or abandonment.

Present commitments from proven North Slope natural gas reserves suggest a 20-year life for the proposed project. Based on the expectation of possible additional Alaskan natural gas discoveries, there is a probable minimum projected life of 50 years and a possible maximum of 100 years. Therefore, the benefit arising from this project is the anticipated continuing supply of a clean and relatively inexpensive energy resource to the Applicants' service area of 94,000 square miles, involving 8.6 million people, and 2.5 million customers. The gas is used for producing electricity as well as a direct energy source.

The major benefits from the project are expected to accrue to the industrial and urban segments of society, but many of the adverse impacts will be borne by the rural environment. Some of the short-term impacts necessary to achieve the benefits are discussed in Section 6.1.4.2.

6.1.4.2 Environmental and Resource Values Affected

Reduction of Soil Productivity

Disturbance of the soil along the route will involve approximately 11,000 acres, of which 1,150 acres have not been previously disturbed. Mixing of subsoil with topsoil will be an unavoidable impact on 890 acres.

Of the 11,000 acres, between 4,800 and 5,100 acres are cultivated agricultural land. Soil productivity on these lands will be affected for a long time from the disturbance, mixing, and compaction of the topsoil by construction activities. An estimated 150,000 bushels of grain will be lost annually for each growing season that these acres are out of production. There should be almost full recovery of these agricultural lands in 1 or 2 years, depending on the success of rehabilitative and restorative efforts.

Fish and Wildlife

The long-term consequences of the proposed action on fish and wildlife and their habitats will generally be minimal, because their species and numbers are already adjusted to the impacts of the existing pipeline.

If construction is avoided during critical nesting periods, almost all terrestrial wildlife and their associated habitats will be affected for a short-term. Aquatic communities will not be significantly affected, if care

is used to avoid crossing streams during spawning seasons snd if stream banks are stabilized as quickly as possible.

1) A beneficial effect on some wildlife in forested areas will begin from the time of the right-of-way abandonment until the right-of-way returns to climax vegetation. This time span will vary widely from one geographic area to another, and in some areas will take 50 to 100 years. There will be an increase in habitat diversity, resulting in greater species diversity and also in a greater number of individuals. The sub-climax vegetation consisting of weeds, herbs, and young shrubs are generally more nutritious for plant-feeding wildlife. Predators, such as hawks, benefit from the opened areas of the right-of-way.

2) A potential adverse long-term effect in fragile areas (severe site characteristics) will be the failure to completely revegetate because of soil disturbance or removal. These fragile areas are mainly semidesert or sand dunes. Vegetative cover will remain sparse, plant species composition will be altered, and basic biological productivity will be decreased. The long-term effect will be a slight decrease in wildlife population levels since the area of the right-of-way must be considered as a small part of the home range of most animals found in its vicinity.

Individuals of species may be lost through habitat destruction, displacement, or disturbance by increased human activity. Cutting of nesting trees could reduce numbers of eagles and hawks. Sediment from stream crossings will smother fish eggs and displace fish from their home territories. This displacement will result in small mortalities of resident fish. Disturbance will displace seclusive species from normal home ranges and result in stress and increased susceptibility to predation.

Vegetation

Vegetation now occupying the proposed right-of-way includes annual forbs and native grasses, annual cultivated crops, perennial grasses and shrubs, and mature and immature timber stands. Therefore, environmental values of the vegetative cover are multifaceted, and are keyed to many current and projected uses of the lands adjacent to the right-of-way.

Construction of the pipeline will disturb vegetation on approximately 11,000 acres. Approximately 1,150 acres of forest and range vegetation previously undisturbed will be affected. Including the John Day River crossing, some 690 acres will become a part of the permanent right-of-way, encumbered for the life of the project.

Rare and Endangered Species

The probability is low that rare and endangered plant species will be affected by the pipeline due to the relatively small surface area utilized by the right-of-way. However, whether or not such species will be affected at all can only be determined through a detailed field survey of the right-of-way by appropriate specialists. No rare or endangered plant species have been identified on the right-of-way.

Archeological and Historical

The possibility exists that short-term use of the proposed right-of-way will result in the loss of archeological values. Any losses incurred would be related to the rapid pace of construction which would lessen the

available time to make detailed investigations and studies of newly discovered sites. Archeological values could be destroyed during construction or by certain segments of the general public who could discover and destroy sites near the pipeline.

Long-term values, if any, will be reduced to the extent that the archeologic resources lost during construction will not be available for interpretation, education, enjoyment, and heritage for future generations. However, if any new sites are discovered and properly investigated prior to project construction, such action will add to long-term values of these resources.

Air and Water Quality

Both surface and groundwater will be used during construction activities. Since the construction period is considered to be short-term, these water uses are not expected to affect the long-term productivity of the water resource, including its quality. Large ground water aquifers of the Spokane and Sacramento river valleys will not be affected during the short- or long-term periods.

Increase in suspended and bedload sediments in surface water will occur during the construction period, and then return to normal. Erosion control measures proposed for stabilizing stream channels and hillslides after disturbance during construction will reduce both short-term and long-term erosion. The proposed pipeline right-of-way includes soils that are highly susceptible to wind erosion in the Columbia River Plateau segment south of Spokane to the John Day River. If revegetation and rehabilitation measures are successful immediately following construction, air quality degradation and wind-borne soil losses will be of short duration.

Recreation and Esthetics

The main impacts of construction of the pipeline on the recreation resources are: 1) disruption of wildlife habitat; 2) a temporary suspension in boating and fishing activity at stream crossings; 3) temporary increases in noise, dust, vehicular traffic, and human activity; 4) temporary disruption of normal wildlife activities in the vicinity of the proposed pipeline corridor; 5) temporary restriction in the freedom of movement by recreationists. If construction takes place during the height of the tourist season, adequate lodging and accommodations could be adversely affected.

Each of the above impacts would be short-lived and will stop when construction activities are terminated.

During the operation and maintenance period, the noise level will be slightly increased at four compressor stations. However, the increase will be within allowable limits prescribed by EPA. The increased noise level from annual blowdowns of the new pipeline will not have a significant impact upon recreation areas and sites near compressor stations and blowdown valves. This noise impact will persist throughout the life of the project.

Most of the right-of-way and some access roads will be cleared of 14-year old vegetation growth. This will tend to attract off-road vehicle users and hikers, especially in forested areas, until vegetation again becomes too dense to permit easy travel on the right-of-way.

None of the impacts on recreation or esthetics would extend into the long-term period.

Health and Safety

The safety hazards that will occur during the construction period are those normally associated with heavy construction projects. Additionally, while natural gas pipelines pose a hazard during the short term period, the existing pipeline has been operated without injuries to the public.

If the pipeline is not removed, cave-ins and the attraction to explore the pipeline could constitute a safety hazard in the long term. Complete removal of the pipeline accompanied by rehabilitation of the right-of-way would avoid the great majority of these risks.

6.1.4.3 Restrictions to Future Options and Needs

Land Use

All land on the existing pipeline right-of-way has some restrictions of land use for the life of the project. The same restrictions will apply to lands needed for the proposed project. The major restrictions are: 1) easements restrict the construction of buildings on private lands; 2) FHA requires homes to be at least 10 feet from pipeline rights-of-way and incorporates DOT pipeline construction regulations.

Since the proposed project will be built primarily within the existing right-of-way across rural private lands, there will be an insignificant additional area in which restrictions to constructing buildings will apply.

Mineral Resources

Sand and gravel deposits comprise most of the known mineral resources along the pipeline route. These deposits are readily accessible and therefore the pipeline would have no impact on their future availability. Other minerals include diatomaceous earth, decorative stone, clay, and coal. Geothermal sites are within a few miles of the right-of-way. The use of these resources is unrestricted by the existing pipeline and would probably be similarly unrestricted by the proposed project. The possibility exists that some new mineral deposit or geothermal location would be found in which there would be conflict between operation of the pipelines and extraction of the resource. Even so, such conflict would be expected to exist only where open pit extraction methods were employed. If warranted by the economic value of the mineral deposit, the pipeline could be moved. At present, there is no evidence to indicate there would be any long-term impacts on mineral resources use as a result of short-term operation of the pipeline.

Availability of Fuel

As explained in Section 1.1.4.1 the known and committed reserves of natural gas to be transported by the proposed pipeline are sufficient for about 20 years at maximum design capacity. The pipeline could also reasonably be used to transport natural gas from other large known and potential reserves in Alaska and Northern Canada which could extend the life of the pipeline in excess of 50 years. Therefore, the increased availability of fuel to the Applicants' market area, although defined as

short-term in this report, could represent a significant number of years beyond the short-term period.

Approximately 20 mcf/d of natural gas consumed by the 16 compressor stations represents only two percent of fuel received at the international border. This should be considered an insignificant impact on the long-term productivity of the natural gas resources. Diesel and gasoline used in construction represents a substantial short-term limitation of fuel available for other uses.

7 IRREVERSIBLE AND IRRETRIEVABLE COMMITMENTS OF RESOURCES IF PROJECT IS IMPLEMENTED

7.1 ARCTIC GAS PIPELINE PROJECT

7.1.4 San Francisco Pipeline

This section describes resources that would be irretrievably committed if the proposed project is constructed. Resources, as used in this section, include not only materials and labor required to construct the pipeline and related facilities, but also natural and cultural values that might be permanently lost as a result of constructing the project.

7.1.4.1 Damages from Natural Catastrophe or Man-Induced Accidents

Loss of Quantities of Natural Gas

A complete failure of one or more sections of this pipeline, while unlikely, could occur. (See Section 3.OV.17.) A rupture could result in an estimated loss of 280,000,000 standard cubic feet of gas. This figure is based on the estimated volume between two mainline block values and the time it would take to manually close the two valves. Automatic closing could reduce this loss to near 160,000,000 standard cubic feet. The heating value of this gas is approximately 280 billion BTU, and 160 BTU, respectively.

Destruction of Vegetation and Wildlife

Natural catastrophies or man-caused accidents such as explosions, fires, and ruptures from earthquakes or slides will have little permanent effect on vegetation, including commercial timber and wildlife, except when occurring in an area of rare or endangered species. Exceptions could occur where accidents might cause destruction of vital segments of habitat such as the black-tailed deer winter range in Shasta County, California. Disruption of water supplies, fish hatcheries, and wildlife refuges along the proposed route could cause elimination of a minimum of whole year classes of fish and wildlife species. Diversion of streams could cause irretrievable loss in fish spawning gravel.

Loss of Materials

A pipeline rupture under external forces would probably result in an irretrievable loss of one or two pipe sections. If a weld failure occurs, it may be necessary to replace many sections depending on the extent of the failure. If the failure occurred at a compressor station and ignition resulted, the entire station could be destroyed. Irretrievable loss of all the station materials could occur. There is little expectation that such an event would happen.

Loss or Damage to Human Populations and Surrounding Property

A slow leak in a high pressure line could be equivalent to some of the leaks which have caused explosions in the recent past. A slow leak usually takes a long time to detect, thereby giving the leaking gas ample opportunity to accumulate in large quantities. A gas transmission line does not directly serve homes, so opportunities for accumulation in closed structures is remote. In addition, it would appear that the possibility of a slow leak is more remote in high pressure lines because of the large

forces involved. Thus, damage to humans or structures from slow leaks is less likely than those from catastrophic releases.

7.1.4.2 Project Structures

The manner of abandonment of this project will be determined by the Federal Power Commission, in accordance with section 7 (b) of the Natural Gas Act, 15 USC 717f(b) in accordance with regulation of the Material Transportation Board, with compliance to regulations developed in the interim period. The Applicant originally stated that all above ground structures and the pipeline could be removed if it is necessary to accomodate future construction. If and when abandonment would become necessary, the pipeline could be removed and the pipe trench restored to original contour with material from the right-of-way and from borrow areas agreed upon with landowners or from commercial sources.

A decision to leave the pipe in the ground, if the proposed project is abandoned, would irreversibly and irretrievably commit about 721,000 tons of steel.

It should be assumed that all project features could be dismantled upon eventual abandonment and only those materials which are impractical to recover will remain. With the rapid reduction of world resources, it appears likely that the steel in the pipeline, compressor stations, and other features would be recovered and reused. Materials to be lost are likely to be lumber, cinder block, concrete, and asphalt. A loss of materials from borrow areas to refill the trench would occur, since the originally removed material will not then be available.

7.1.4.3 Resource Extraction

Natural Gas Resources to be Used

The PGT-PG&E proposed pipeline will carry to the West Coast area an estimated irreversible commitment of 438 billion cubic feet of natural gas per year for an anticipated 20-year period. Of an estimated total commitment of 8.76 trillion cubic feet, about 2.0% would be used for compressor operation on the proposed project.

Other Fuels (fossil, oil, and gasoline)

Petroleum fuels would be used in construction of the proposed line, transporting pipe, machinery, and other materials as required. The estimated 8 to 10 million gallons of these fuels represents an irreversible and irretrievable commitment of these resources. Additionally a like amount would probably be used to salvage the pipe and restore the right-of-way.

Minerals and Materials

Several mineral resources are committed to the project. An estimated 721,000 tons of steel pipe are required plus materials for fittings, compressors, and other equipment. Sand and gravel taken from borrow areas along the proposed route will be committed to the proposed project.

Non-Renewable Resources to be Used by the Project

The construction and operation of the proposed project will include the consumption of 8.76 trillion cubic feet of natural gas, 721,000 tons of steel, 8 to 10 million gallons of petroleum fuels plus oils, grease, cement, welding rods, gravel, etc.

If the proposed pipeline is abandoned, some of the steel pipe may be recoverable if its condition is suitable and a market exists. A 20-year use of the pipeline is anticipated. Since some unknowns related to corrosion, wear, and costs of recovery may be adverse, the steel may become non-retrievable.

7.1.4.4 Erosion

Loss of Topsoil

Construction of the proposed project will result in irreversible and irretrievable losses of topsoil by soil erosion and mixing with subsoils.

Effects on Aquatic Ecosystems and Water Quality

Increased Runoff, Turbidity, and Sedimentation

Although water quality will be impacted on a short-term basis, primarily by increased suspended-sediment concentrations and turbidity levels, there will be no significant permanent or irreversible effects on either surface water or ground water. All impacts involving the degradation of water resources will peak with the construction process and gradually disappear. In the case of increased sediment yields from a right-of-way, the effects may last for longer periods. The hazard of renewed impact by pipeline rupture will, of course, continue until the project is abandoned.

Loss of Spawning and Hatching Grounds

With the eventual revegetation of streambanks and the return to preproject erosion levels, stream turbidity and sedimentation levels should return to normal. After one or more high flow periods, substrate conditions will also return to normal. No irreversible or irretrievable losses of spawning or hatching grounds will occur.

Effects on Sport and Commercial Fisheries

Habitat conditions for sport and commercial fish species will return to substantially preproject conditions after construction is finished and after streambank restoration has taken hold. While there will be some temporary reduction in sport and commercial fishery catch potential until turbidity and sedimentation has returned to normal, no irreversible or irretrievable losses of sport or commercial fishery long term potentials should result from construction of the pipeline.

7.1.4.5 Destruction of Cultural, Archeological, and Historical Sites

Loss of Known and Unknown Sites

The possibility exists that during the trenching operation, one or more underground archeological sites may be found. If this does occur, the

trenching operation will stop until each site can be evaluated. In such cases, only the portion of the site disturbed by the trenching machine will be irretrievably lost.

No known significant historical sites exist on or immediately near the right-of-way.

7.1.4.6 Elimination of Endangered Species Habitats

Rare and endangered birds of prey utilize the same nesting sites year after year. Destruction of such sites along the proposed pipeline will probably cause displacement of adult birds and a reduction in numbers of young produced. There will not be sufficient destruction in habitat of endangered species living along the existing pipeline to have an irreversible effect on any specific species.

Alteration of aquatic environments near the Oregon-California border, through sedimentation and diversion of water flows, could possibly reduce numbers of Lost River sucker, Shortnose sucker, and Rough sculpin. Habitat reduction of other rare and endangered fish species will be less important, since generally, the species involved will move away from the area during construction and return as habitat improves.

7.1.4.7 Irrevocable Changes In Land Use

Changes in Zoning

The existing right-of-way is dedicated primarily for pipeline use. The lands traversed by the proposed project will necessarily be encumbered by the same restrictions upon land use since it will parallel the existing pipeline. The existence of the pipeline will inhibit the development of the land from agricultural to residential, commercial or industrial classification. In this case the permanent losses will be secondary, and a function of demographic patterns.

Increased Housing and Other Construction

The construction of permanent buildings will not be permitted on the land area dedicated for pipeline purposes. The presence of the existing and proposed pipeline will inhibit but not necessarily preclude the development of communities along the proposed route. Apart from the direct loss of some additional land, the presence of the right-of-way will pose a visible interruption of the orderly development of communities. Also, the potential threat of pipeline rupture will pose a secondary obstacle to development. Restrictions of non-resident building in the vicinity of the right-of-way corridor will also inhibit development for the life of the project.

Conflicts With Recreational and Other Future Land Use Plans

The losses of recreational resources will be minimal along the proposed route. Most campgrounds, hunting and fishing areas, picnic grounds, etc., in the vicinity of the existing and proposed route will be indirectly but minimally adversely affected by land use restrictions on the area of the right-of-way. The proposed action would cause some minor damage to the scenic qualities along the right-of-way corridor for the duration of the project.

Approximately 400 acres of forest land will be taken out of commercial forest production for the life of the project.

The proposed project will result in a slight loss of agricultural production after construction of the project. Also, there will be a slight reduction in production from the conservation lands in semi-arid areas.

7.1.4.8 Commitment of Materials and Human Resources

Construction Materials

Most of the 721,000 tons of steel pipe may be recoverable by salvage operations should the system be abandoned. There are irretrievable commitments of materials such as concrete, sand, and gravel. The quantities of these materials have not been estimated. The petroleum fuels used in the project are estimated between 8 and 10 million gallons. In addition, secondary expenditures of similar amounts will probably occur due to construction, commuter traffic, administrative traffic, and related expenses, which will be committed upon construction of the project.

Use of Labor Source for Construction Period

Approximately 1,200 man-years will be needed to construct the pipeline.

8 ALTERNATIVES TO THE PROPOSED ACTION

8.1 ALTERNATIVE GAS PIPELINE ROUTES

8.1.4 San Francisco Pipeline

Introduction

This section concerns only those alternatives directly related to the primary application, i.e., a 42-inch natural gas pipeline paralleling an existing 36-inch pipeline. See Part VI, Alternatives, for other alternative systems such as LNG from Alaska to northern California, joint use of larger pipelines by the Applicant and other companies, extensions of the primary application to southern California, and others. Additionally, because this statement relates only to the environmental impact of the project as proposed by the Applicants, it is not concerned with alternative energy sources. The delivery system proposed by PG&E-PGT would follow an existing pipeline making use of existing facilities. Any alternative route would result in a significantly greater number of environmental impacts. Accordingly, no alternative routes to the Applicant's proposal were considered.

Currently the Applicants have filed four applications with the Department and the FPC. Included in the applications is information on the maximum design capabilities of both a 42-inch and a 36-inch pipeline. A summary of these applications follows:

Pipe Size (inches)	Flow Capacity MMcf/d)	Remarks
42	1,200	Filed 3/21/74. Considered as the primary application for the purpose of this statement. Completely parallels existing line.
36	850	Filed 3/21/74. Completely parallels existing line.
36	200	Filed 7/16/75. Partially loops existing line using most looping now installed.
36	600	Filed 7/16/75. Complete looping of existing line using all loops now installed.
36	1,100	Included in the 7/16/75 filing as a maximum capability design for a 36-inch pipeline. Completely parallels existing line, but uses all loops now installed.

The Applicant feels these filings give the construction flexibility needed because of the uncertainty of natural gas volumes and pipeline pressures from the northern natural gas fields. Other combinations of pipeline size and pressures are possible. However, for the purpose of this statement they are considered as variations having environmental impacts that are not significantly different from the four applications on file.

Because the new routing across the John Day River Canyon was designed to have the least environmental impact, no alternative to the proposed crossing is considered viable.

There is one construction alternative that does not parallel the existing right-of-way. It is a re-routing away from the Moyie River Valley to the Kootenai River Valley.

8.1.4.1 Pipeline Size Alternative

The only pipeline size considered as an alternative to the 42-inch pipeline is a 36-inch one. Other pipeline sizes are possible, but the smallest diameter pipelines would not provide efficient transportation. Consequently, only larger sizes are viable alternatives.

Variations in larger size pipelines normally do not have significant differences in impacts on the environment. Impacts are more affected by route locations, length of routes, season and methods of construction, and number, location, and size of compressor stations. Differences in pipeline diameters have even less significant environmental impacts when a new pipeline is installed adjacent to an existing pipeline.

The Applicant advises that either a 36- or 42-inch diameter pipeline will be constructed primarily within 70 feet of the existing 100-foot wide right-of-way across private lands. Acreage impacted will be approximately the same for both; all acreage within the right-of-way will be re-impacted. On Federal lands the permanent right-of-way will be 6-inches wider for the 42-inch pipeline than for the 36-inch pipeline and the temporary work areas will be the same for both pipe sizes.

Trench excavation volumes for a 36-inch pipeline will be less than for a 42-inch pipeline by an estimated 18 percent. All other design factors being equal, the environment is impacted more by differences in volumes of trench excavations than anything else. Consequently, the differences in environmental impacts between a 42- and 36-inch pipeline paralleling an existing pipeline are considered to be negligible.

8.1.4.2 Alternative Designs

System Designs

All alternatives involve variations in both pressures and looping using 36-inch diameter pipe. See Table 8.1.4.2-1 for basic information on the alternative designs, namely the "1830," "2080," "1180," and "1580." Note especially that the 1830 and 2080 designs require 917 miles of pipeline construction, while the 1180 and 1580 designs require 458.4 and 873.5 miles, respectively.

Table 8.1.4.2-2 shows the location of construction for the 1180 design -- a partial looping of the existing pipeline. The 1580 design is a full looping of the existing pipeline. Both the 1180 and 1580 designs use existing inplace loop or security crossings completed in 1970 across the Kootenai, Pend Oreille, Snake, Umatilla, Sprague, and Pit Rivers.

Description of the Environment

The environment as described in section 2.1.4 is applicable to all the 36-inch diameter pipeline alternatives.

Table 8.1.4.2-1 Design comparisons.

Pipeline Size	Design Flow Rate (MMcf/d) Existing	Proposed	Total	MAOP (psig)	Miles of Pipeline to be Installed PGT	PG&E	Total	Additions to Compressor Stations
42"	980	1,200	2,180	1,440/1,250/1,040	618.1	298.9	917.0	4
36"	980	850	1,830	1,440/1,250/1,040	618.1	298.9	917.0 1/	4
36"	980	200	1,180	911/975	319.6	138.8	458.4 2/	-
36"	980	600	1,580	911/1,040/975	591.9	281.6	873.5 3/	-

1/ Completely parallels existing line; does not use existing loops. A fully powered 36" pipeline with a MAOP of 911 psig and requiring 32 new compressors at 16 existing stations would provide 1,100 MMcf/d (or a combined 2,080 MMcf/d).

2/ Partial looping of the existing line using most of the installed loops.

3/ Complete looping of the existing line using all of the existing loops.

Table 8.1.4.2-2 1180 pipeline loops.

Loop Number	Description	Length
1180-1	M.P. 0.0 to M.P. 7.9	7.9 Miles
1180-2	M.P. 31.5 to M.P. 61.1	29.6 Miles
1180-3	M.P. 61.8 to M.P. 68.5	6.9 Miles
1180-4	M.P. 108.0 to M.P. 170.7	62.6 Miles
1180-5	M.P. 197.5 to M.P. 206.3	8.9 Miles
1180-6	M.P. 208.2 to M.P. 216.9	8.6 Miles
1180-7	M.P. 277.1 to M.P. 282.8	5.7 Miles
1180-8	M.P. 284.4 to M.P. 319.9	35.4 Miles
1180-9	M.P. 350.4 to M.P. 405.8	60.4 Miles
1180-10	M.P. 454.4 to M.P. 498.4	43.9 Miles
1180-11	M.P. 552.5 to M.P. 570.7	18.2 Miles
1180-12	M.P. 581.0 to M.P. 619.6	38.6 Miles
1180-13	M.P. 619.6 to M.P. 636.3	16.7 Miles
1180-14	M.P. 636.3 to M.P. 643.9	7.6 Miles
1180-15	M.P. 643.9 to M.P. 703.6	59.7 Miles
1180-16	M.P. 703.6 to M.P. 751.3	47.7 Miles

Environmental Impact

The relative environmental impacts associated with the various 36-inch designs are shown in Table 8.1.4.2-3. The most important factors influencing the relative environmental impacts are miles of construction, size of trench excavation, maximum allowable operating pressure, use of existing stream crossings and other loops, number of compressors, and cost of construction.

Section 3.1.4 evaluates impacts for the 42-inch pipeline. Relating Table 8.1.4.2-3 to Section 3.1.4 and the mitigations in Section 4.1.4 provides quantum values for environmental impacts associated with the various 36-inch pipeline designs.

8.1.4.3 Moyie River Alternative Route

Description of the Alternative Route

An alternative route has been suggested in lieu of the Applicant proposal of paralleling the existing pipeline through the Moyie River Valley (MP 00 to 31.5). The alternative route would leave the Moyie River Valley at MP 2.5, parallel Highway 95 west through Round Prairie, and then follow the Kootenai River Valley south. The alternative route would join the existing and proposed route south of the Kootenai River near MP 31.5. See Figure 8.1.4.3-1.

Description of the Environment

The environment as described in Section 2.1.4 concerning the proposed route is applicable to the alternative route. Some chief differences between the two routes are:

	Proposed	Alternative
miles through forested lands	6	13
miles through agriculture lands	23	16
Total miles	29	29
Moyie River Crossings	8	2

In the event a 36-inch pipeline is constructed, an existing loop across the Kootenai River could be used on the proposed parallel route, while it would not likely be used for the alternative route. See Table 8.1.4.3-1 for additional data relative to the differences between the two routes.

Environmental Impacts

Only 13 additional acres of Federal lands along the Moyie River will be impacted if the proposed parallel route is used. If the alternative route is used, an estimated 342 acres (34 Federal and 308 private) of additional land will be impacted for the first time. All private lands to be used in the proposed parallel route have already been impacted when the existing pipeline was constructed in 1961.

From strictly an environmental viewpoint, the alternative route requires more new acres to be dedicated to a pipeline and contains more adverse impacts.

Table 8.1.4.2-3 Relative impacts of alternative designs.

Alternative Design	Climate	Topography	Geology	Soils	Water Resources	Vegetation	Wildlife	Ecological Factors	Social and Economic Factors	Land Use	Archeological and Historical Resources	Recreation and Aesthetic Resources	Air Quality	Noise	Hazards
42" - 2180 (Primary)	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
36" - 2080	10	8	8	9	10	10	10	10	9	10	10	10	11	15	11
36" - 1830	10	8	8	9	10	10	10	10	7	10	10	10	10	10	10
36" - 1580	10	6	7	8	5	9	9	9	5	9	9	9	4	9	10
36" - 1180	10	4	4	4	4	5	5	5	3	5	5	5	2	9	5

This figure rates relative impacts on a scale of 1 to 10. It arbitrarily assigns a 10 rating to all impacts associated with the primary application (42", 2180 design) regardless of the significance of the impact. Consequently, a 10 rating for any impact of an alternative design means the degree of impact is equal to the primary design. Ratings below or above 10 indicate a relative impact of less or more, respectively, than the impact associated with the primary design.

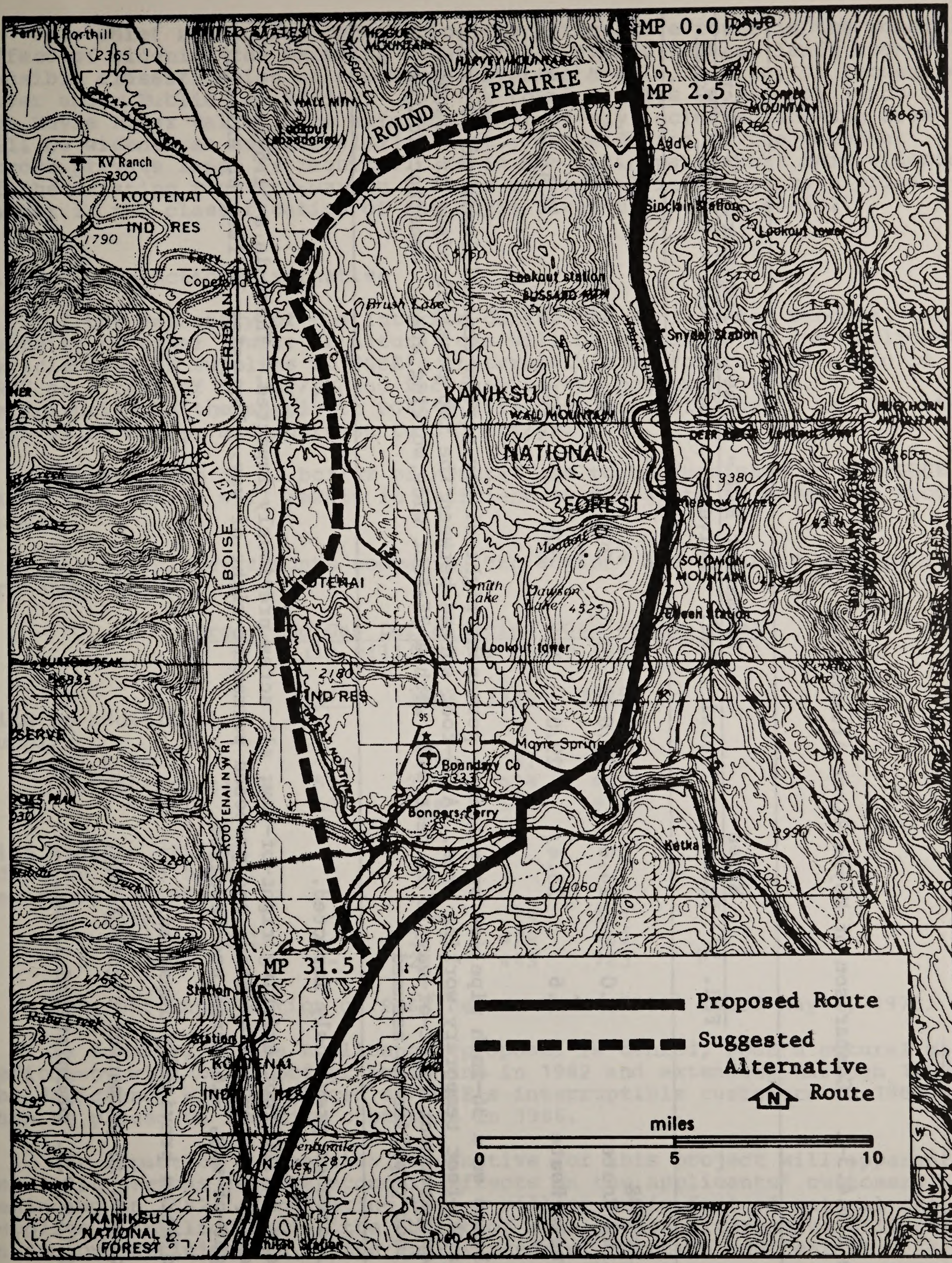

Figure 8.1.4.3-1 Alternative to the Moyie river route

Table 8.1.4.3-1 Comparison of Moyie River Alternative

	Miles			Permanent R/W - Acres			Temporary R/W - Acres		
	Fed. 5/	Private	Total	Fed.	Private	Total	Fed.	Private	Total
Paralleling Existing Route	5.0	24.0	29.0	13 1/	291 2/	304	15 3/	0 4/	15
Alternate Route	3.6	25.4	29.0	23	308	331	11	0 4/	11

Data based on a 36-inch pipeline on original permanent right-of-way across Federal lands of 50 feet with a 25-foot temporary working area. A 20-foot spread between the two parallel pipes is assumed. The new permanent right-of-way is 53 feet wide with a 25-foot wide working area. Construction of a 36-inch pipeline is assumed.

1/ All acreage previously impacted.

2/ Based on 100-foot existing right-of-way; all acres previously impacted. There is a 31.5-foot overlap between the existing and proposed permanent right-of-way. For using 70 feet of existing right-of-way, 216 acres are required.

3/ Two acres previously impacted.

4/ Included in permanent right-of-way.

5/ All U.S.F.S. administered lands.

The chief reason for considering the alternative route is the possible effect of widening the existing right-of-way across Federal lands upon a possible classification of the Moyie River as a wild, scenic, or recreation river under Public Law 90-542. For the total 5 miles of Federal lands in the Moyie River Valley, the existing right-of-way including working area will be widened an additional 21.5 feet. (No widening of the easement across private lands is required.) It is not anticipated that this widening of the existing right-of-way on 5 miles of Federal land will be a primary factor in the classification of the Moyie River under P.L. 90-542.

8.1.4.4 No Action Alternative

If the Secretary of the Interior denies the Applicants' proposal and assuming no other source of natural gas will be available to the Applicants, deficiencies in supplies to PG&E's interruptible customers will begin in 1977 at a rate of 53 bcf/yr and increase to 462 bcf/yr by 1990. Deficiencies in the supply to PG&E's firm customers will begin in 1986 at a rate of 87 bcf/yr and increase to 347 bcf/yr.

The addition of 73 bcf/yr of natural gas to be furnished to PGT-PG&E by EXXON from Alaska will result in deficiencies not quite as severe as shown above.

The deficiency amounts comparing "no action" and "action" alternatives are shown below.

Projected Gas Deficiencies PG&E Market Area
(in Billions of Cubic Feet)*

	1977	1982	1986	1990
With no additional supply				
Firm	--	--	87	374
Interruptible	53	284	429	462
Total	53	284	516	836
With Alaskan (EXXON) addition of 73 bcf/yr beginning in 1982				
Firm	--	--	14	301
Interruptible	--	211	429	462
Total	--	211	443	763

*Source: Application of PG&E before CPUC #55661 filed May 1, 1975.

In summary, if the Applicants' proposal is denied, PG&E's natural gas deficiency will be 73 bcf/yr beginning in 1982 and extending through 1990. The deficiency will be placed on PG&E's interruptible customers in 1982 and then be placed on its firm customers in 1986.

The impact of a no-action alternative for this project will apparently result in serious adverse economic effects on the Applicants' customers beginning in 1982. Considering that 1 billion cubic feet of natural gas supplies 1 trillion Btu's, the impact of a no-action alternative will result in serious deficiencies on the energy needs of northern and central California industries, services, and homes.

APPENDIX TO SECTION 2

The material in this appendix is supplemental to Sections 2.1.4.6 and 2.1.4.13.

A2.1.4.6--Typical Plants Within the Vegetative Types Crossed by the Pipeline Right-of-Way
Montane Forests (M.P. 0.0 - M.P. 110)

Coniferous forest species

Western white pine	Pinus monticola
Ponderosa pine	Pinus ponderosa
Lodgepole pine	Pinus contorta
White bark pine	Pinus albicaulis
Western larch	Larix occidentalis
Douglas-fir	Pseudotsuga menziesii
Engelmann spruce	Picea engelmannii
White fir	Abies concolor
Grand fir	Abies grandis
Subalpine fir	Abies lasiocarpa
Pacific yew	Taxus brevifolia
Western hemlock	Tsuga heterophylla
Western redcedar	Thuja plicata

Deciduous forest species

Ceanothus	Ceanothus fendleri
Pacific willow	Salis lasiandra
Paper birch	Betula papyrifera
Thinleaf alder	Alnus tenuifolia
Red alder	Alnus rubra
Black cottonwood	Populus trichocarpa
Quaking aspen	Populus tremuloides
Rocky mountain maple	Acer glabrum
Black hawthorn	Crataegus douglasii
Common chokecherry	Prunus virginiana
Bitter cherry	Prunus emarginata
Service berry	Amelanchier alnifolia
Rocky-mountain ash	Sorbus scopulina
Cascara	Rhamnus purshiana
Red-osier dogwood	Cornus stolonifera
Snowberry	Symphoricarpos occidentalis
Buffalo berry	Shepherdia canadensis
Bitterbush	Prushia tridentata

Forbs

Cinquefoil	Potentilla spp.
Strawberry	Fragaria spp.
Butterweed	Senecio triangularis
Goldenrod	Solidago spp.
Yarrow	Achillea millefolium
Bracken fern	Pteridium aquilinum
Pachistima	Pachistima myrsinites
Elk sedge	Carex geyerii
Ross sedge	Carex rossii

Grasses

Slender wheat grass	Agropyron tenerum

Bunch wheat grass	Agropyron spicatum
Bunch fescue	Festuca scabrella
Idaho fescue	Festuca idahoensis
Western fescue	Festuca occidentalis
Pinegrass	Calamagrostis rubescens
Macoun's reedgrass	Calamagrostis macouniana
Canada bluegrass	Poa compressa
Thurber needlegrass	Stipa thurberiana
Western needlegrass	Stipa occidentalis
Columbia needlegrass	Stipa columbiana
Bluebunch wheatgrass	Agropyron spicatum
Beargrass	Nolina bigelovii
Elmer needlegrass	Stipa elmeri

Palouse Prairie Grassland (M.P. 110 to M.P. 430)

No significant trees.

Forbs or shrubs

Stiff sagebrush (rigid)	Artemisia rigida
Large-flowered brodiaea	Brodiaea douglassi
Yellow fritillary	Fritillaria pudica
Purple-eyed grass	Sisyrinchium inflatum
Pigweed	Chenopodium album
Pigweed amaranth	Amaranthus retroflexus
Slender fringe-cup	Lithophragma bulbifera
Sticky geranium	Geranium viscosissium
Dwarf hesperochiron	Hesperochiron pumilus
Yarrow	Achillea millefolium
Sedges	Carex spp.
Camass	Camassia quamash
Blue flag	Iris missouriensis
Wild onions	Allium spp.
Mustard	Brassica spp.
Big sagebrush	Artemisia tridentata
Bitterbrush	Purshia tridentata

Grasses

Blue grama	Bouteloua gracilis
Six weeks fescue	Festuca octoflora
Blue bunch fescue	Festuca idahoensis
Mountain brome	Bromus carinatus
Smooth brome	Bromus intermis
Downy brome grass	Bromus tectorum
Foxtail brome	Bromus rubens
Bulbous bluegrass	Poa bulbosa
Kentucky bluegrass	Poa pretensis
Pine bluegrass	Poa scabrella
Annual bluegrass	Poa annua
Sandberg bluegrass	Poa secunda
Foxtail barley	Hordeum jubatum
Darnel grass	Lolium temulentum
Italian ryegrass	Lolium multiflorum
Bluebunch wheatgrass	Agropyron spicatum
Junegrass	Koeleria cristata
Squirreltail grass	Sitanion hystrix
Tall oatgrass	Arrhenaterum elatius
Spike trisetum	Trisetum spicatum

Wild oats	Avena fatua
California oatgrass	Danthonia californica
Common velvetgrass	Holcus lanatus
Creeping bentgrass	Agrostis palustris
Field sandbur	Cenchrus pauciflorus
Yellow foxtail	Setaria lutescens
Barnyard grass	Echinochloa crusgalli
Crabgrass	Digitaria sanguinalis
Timothy	Phleum pratense
Redtop	Argrostis palustris
Needle and thread	Stipa comata
Idaho fescue	Festuca idahoensis
Indian ricegrass	Cryzopsis hymenoides
Thurber needlegrass	Stipa thurberiana
Wyeth buckwheat	Eriogonum heracleoides

Cold Desert (M.P. 430 to M.P. 455 and M.P. 590 to M.P. 637)

Trees

Western yellow pine	Pinus ponderosa
Western juniper	Juniperus occidentalis

Shrubs

Rigid sagebrush	Artemisia rigida
Desert mountain mahogany	Cercocarpus ledifolius
Squaw currant	Ribes erythrocarpum
Plateau gooseberry	Ribes velutinum
Fern bush (Desert sweet)	Chanaebatiaria millefolium
Buckbrush	Ceanothus cuneatus
Gray ball sage	Salvia dorrii subsp. carnosa
Gray rabbit brush	Chrysothamnus nauseosus
Big Sagebrush	Artemisia tridentata
Spineless horse brush	Tetradymia canescens
Antelope bush (Bitterbrush)	Purshia tridentata
Greasewood	Sarcobatus vermiculatus
Snowberry	Symphoricarpos occidentalis

Forbs

Desert lily	Calochortus macrocarpus
Buckwheat spp.	Eriogonum spp.
Dock spp.	Rumex spp.
Smartweed spp.	Polygonum spp.
Lupine	Lupinus spp.
Western blue flax	Linum perenne spp. lewisii
Phacelia spp. (Fiddlenecks)	Phacelia spp.
Monkey flower	Mimulus spp.
Ashy penstemon	Penstemon cinereus
Penstemon	Penstemon spp.
Desert paintbrush	Castilleja linariaefolia
Arrow-leaved balsam root	Balsamorhiza sagittata
Aster	Aster spp.
Daisy	Erigeron spp.

Grasses

Blue bunch fescue	Festuca idahoensis
Downy brome (Cheat)	Bromus tectorum

Bluebunch wheatgrass	Agropyron spicatum
Squirrel-tail grass	Sitanion hystrix
Soft chess	Bromus mollis
Wild barleys	Hordeum spp.
Needle grasses	Stipa spp.
Blue grasses	Poa spp.
Fescue	Festuca spp.
Idaho fescue	Festuca idahoensis
Basin wildrye	Elymus cinereus
Saltgrass	Distichlis stricta
Sandberg bluegrass	Poa secunda

Montane Coniferous Forest (M.P. 455 to M.P. 590 and M.P. 637 to M.P. 707)

Trees

Western yellow pine	Pinus ponderosa
Western white pine	Pinus monticola
Lodgepole pine	Pinus contorta
Western larch	Larix occidentalis
Douglas-fir	Pseudosuga menziesii
Grand fir	Abies grandis
White fir	Abies concolor
Incense cedar	Libocedrus decurrens
Western juniper	Juniper occidentalis
Quaking aspen	Populus tremuloides
Oregon white oak	Quercus garryana

Shrubs

Mountain mahogany	Cercocarpus betuloides
Spiny spirea	Spirea lucida
Cream bush	Holodiscus discolor
Antelope bush (Bitterbrush)	Purshia tridentata
Nootka rose	Rosa nutkana
Greenleaf manzanita	Arctostaphylos patula
Snowberry spp.	Symphoricarpos spp.
Big sagebrush	Artemisia tridentata
Buck brush	Ceanothus spp.
Bear-berry	Arctostaphylos uva-ursi
Low sagebrush	Artemisia arbuscula

Forbs

Spreading dogbane	Apocynum androseamifolium
Virgate phacelia	Phacelia heterophylla
Scarlet paintbrush	Castilleja miniata
Arrow-leaved balsam root	Balsamorhiza sagittata
Fleabane	Erigeron compositus
Yarrow	Achillea millefolium
Heart-leaved arnica	Arnica cordifolia
Rosy everlasting	Antennaria rosea
Klamath plume	Hypericum perforatum
Fularee	Erodium cicutarium

Grasses and Grass-like Plants

The long history of stock grazing in this vegetative type has profoundly modified the primeval grass components. Many perennial bunch grasses have been superseded by invading exotic grasses.

Blue bunch fescue	Pestuca scabrella
Downy cheat	Bromus tectorum
Brome spp.	Bromus spp.
Rye grass spp.	Lolium spp.
Squirrel-tail grass	Sitanion hystrix
Wild oats	Avena aatua
Wild barleys	Hordeum spp.
Blue grasses	Poa spp.
California needlegrass	Stipa californica
Tickle grass	Agrostis scabra
Idaho bent-grass	Agrostis idahoensis
Idaho fescue	Festuca idahoensis
Bluebunch wheatgrass	Agropyron spicatum
Thurber needlegrass	Stipa thurberiana
Indian ricegrass	Oryzopsis hymenoides
Sandberg bluegrass	Poa secunda
Tufted hairgrass	Deschampsia colspitosa
Oregon redtop	Agrostis oregonensis
Desert saltgrass	Distichlis stricta
Alkali sacaton	Sporobolus airoides
Soft chess	Bromus mollis
Nebraska sedge	Carex nebraskensis

Woodland-Bushland (Broad Sclerophyll) (M.P. 707 to M.P. 732)

Trees

Digger pine	Pinus sabiniana
Big-cone pine	Pinus coulteri
Live oaks	Quercus spp.
Blue oak	Quercus douqlasii
Valley oak	Quercus lobata
Golden cup oak	Quercus chrysolepis
Buckeye	Aesculus californica
California laurel	Umbellularia californica

Shrubs and Forbs

California buckthorn	Rhamnus californica
Buckbrush	Ceanothus cuneatus
California Redbud	Cercis occidentalis
Yerba Santa	Eriodictyon californicum
Oak gooseberry	Ribes quercetorum
Chamise	Adenostoma fasciculatum
Toyon	Photinia arbutifolia
Mountain mahogany	Cercocarpus betuloides
Poison Oak	Rhus diversiloba
Black mustard	Brassica nigra
Milkweed	Asclepias spp.
Goosefoot	Chenopodium spp.
Owls clover	Orthocarpus spp.
Scarlet pimpernel	Anagallis arvensis
Brodiaea	Brodiaea spp.
California buttercup	Ranunculus californicus
Baby blue eyes	Nemophila menziesii

Filaree	<u>Erodium cicutarium</u>
Bur clover	<u>Medicago hispida</u>

<u>Grasses</u>

Ripgut brome	<u>Bromus rigidus</u>
Foxtail brome	<u>Bromus rubens</u>
Soft chess	<u>Bromus mollis</u>
Six weeks fescue	<u>Festuca octoflora</u>
Italian ryegrass	<u>Lolium multiflorum</u>
Mouse barley	<u>Hordeum murinum</u>
Wild barleys	<u>Hordeum spp.</u>
Wild oats	<u>Avena fatua</u>
California oatgrass	<u>Danthonia californica</u>
Creeping bentgrass	<u>Agrostis palustris</u>
California needle grass	<u>Stipa pulchra</u>
Canary grass	<u>Phalaris spp.</u>

California Prairie Grassland (M.P. 732 to M.P. 917)

<u>Trees</u>

Valley oak	<u>Quercus lobata</u>
Blue oak	<u>Quercus douglasii</u>
Interior live oak	<u>Quercus wislizenii</u>
Eucalyptus	<u>Eucalyptus spp.</u>
Cottonwoods	<u>Populus spp.</u>

<u>Shrubs</u>

Shrubs are few, except for streamside brush or invaders along canals and ditch banks.

<u>Forbs</u>

rushes	<u>Juncus spp.</u>
Curly dock	<u>Rumex Crispus</u>
California goldenrod	<u>Solidago californica</u>
Goldfields	<u>Baeria spp.</u>
Common groundsel	<u>Senecio vulgaris</u>
Tidy tips	<u>Layia platyglossa</u>
Yellow star thistle	<u>Centaurea solstitialis</u>
Napa thistle	<u>Centaurea melitensis</u>
Madia	<u>Madia elegans</u>
Horehound	<u>Marraumbium vulgare</u>
Yellow mustard	<u>Brassica compestris</u>
Filaree	<u>Erodium cicutarium</u>
Bur clover	<u>Medicago hispida</u>

<u>Grasses and grass-like plants</u>

Soft chess	<u>Bromus mollis</u>
Wild oat	<u>Avena fatua</u>
Sedges	<u>Carex spp.</u>

A2.1.4.13 Landscape Sensitivity and Variety

The character and visibility of the aesthetic environment along the proposed pipeline route were quantified using systems developed by the Forest Service (Bacon 1972), and the Bureau of Land Management. These systems are based on assessing the variety and sensitivity of landscapes.

Sensitivity

The term sensitivity as used in this evaluation provides a measure of the visual use of a landscape. The sensitivity is determined by:

- The number of people who view the landscape and have a major interest in visual qualities; and
- The amount of time people spend viewing the landscape.

An example of a very sensitive landscape would be the landscape viewed from a vista turnout along a major tourist highway where numerous viewers who have an interest in scenic values are inclined to stop, focus attention on a single landscape, and perhaps linger. Sensitivity diminishes with a decrease in the number of people interested in scenic quality who view an area, or with a decrease in the duration of viewing time.

Three classes of sensitivity are used to describe the aesthetic environment along the proposed pipeline route. These classes are:

Class	
1	Highest sensitivity
2	Average sensitivity
3	Presently unseen by the general public

General Classification of Landscape Sensitivity

Class 1	Class 2	Class 3
Landscapes viewed from PRINCIPAL travel routes, public use areas, and water bodies with either: (a) a primary function of serving users who have a major interest in scenic qualities, as indicated by 75 percent recreational traffic or usage. (b) a secondary function of serving	Landscapes viewed from PRINCIPAL travel routes, public use areas, and water bodies not included in Class 1. Landscapes viewed from MINOR travel routes, public use areas, and water bodies with a secondary function of serving users who have a major interest in scenic qualities, as indicated by between 25 percent and 75 percent recreatical traffic or usage.	Landscapes viewed from MINOR travel routes, public use areas, and water bodies with little function to serve users who have a major interest in scenic qualities, as indicated by less than 25 percent recreational traffic or usage. Landscapes unseen from any travel route, public use area, or water body.

users who have a major interest in scenic qualities, as indicated by 25 percent recreational traffic or usage.	Landscapes viewed from urban areas and other smaller communities.
Landscapes viewed from MINOR travel routes, public use areas, and water bodies with a primary function of serving users who have a major interest in scenic qualities, as indicated by 75 percent recreational traffic or usage.	

Source: USDI, Forest Service, Visual Management System, undated.

Variety

The term variety as used in this evaluation is defined as the amount of diversity found in the components of a landscape: the vegetative patterns, landforms, rock formations, waterforms, structures, and climatic conditions. These landscape components are seen in terms of their elements: form, line, color, texture, uniqueness and intrusions. The prominence of a component within a landscape is determined by the influence of these elements. The following is a brief clarification of the six elements and how they are perceived in terms of landscape components:

Line

In the natural landscape, lines may be formed by ridges, skylines, changes in vegetative types, or by individual trees and branches. When man's activities are introduced, additional lines are added by roads, fences, powerlines, etc.

Form

Form is the shape of the ground surface, usually the result of some type of erosion.

Texture

Texture is the result of the size, shape, and placement of parts, their uniformity, and the distance from which they are being observed. Texture, as it is perceived in the landscape, is usually the result of the vegetation or vegetative patterns on the landscape. Texture may also be the result of the erosive patterns in rocks or soil.

Color

Color may be in the vegetation, soil, rocks, water, etc., and may vary with the time of day, time of year, and with weather (USDI, BLM, 1973).

Uniqueness

This factor provides an opportunity to give added importance to one or all of the scenic features that appear to be relatively unique within any one physiographic region. There may also be cases where a separate evaluation of each of the key factors does not give a true picture of the overall scenic quality of an area. Often it is a number of not so spectacular elements in the proper combination that produces the most pleasing scenery (USDI, BLM, 1972).

Intrusions

Consider the impact of man-made improvements on the aesthetic quality. These intrusions can have a positive or negative aesthetic impact (USDI, BLM, 1972).

Three classes of variety are used to describe the aesthetic environment along the proposed pipeline route. These classes are:

	Class
A	Unusual variety
B	Variety
C	Minimal variety

Each landscape component is examined and classified as to variety (Bacon, 1972). The term "unusual" signifies that the component is seldom or not typically found in the geographic context. "Common" means frequently encountered or widespread; and "uniform" means repetitious or continuously encountered. Type landscapes of national importance are arbitrarily assigned to Class A. Each geographic landscape is first classified using the region or the country as a whole as a frame of reference. Then, each type landscape is classified using the geographic landscape as a frame of reference.

General Classification of Landscape Variety

	Class A Unusual Variety	Class B Some Variety	Class C Minimal Variety
Landforms Hills, valleys, plains and other	National Importance Unusual Topography	Common Topography	Uniform Topography
Rock Formulations	National Importance Unusual Size Unusual Shape Unusual Texture Unusual Distribution	Common Size Common Shape Common Texture Common Distribution	Uniform Shape Uniform Texture Uniform Distribution

Water Forms	National Importance		
	Unusual Size	Common Size	
Lakes	Unusual Shoreline	Common Shoreline	Uniform Shoreline
	High Water Quality	Average Water Quality	Low Water Quality
	Unusual Reflections	Common Reflections	No Reflections
Streams	National Importance		
	Unusual Motion	Common Motion	Still
	Unusual Configuration	Common Configuration	Uniform Configuration
	High Water Quality	Average Water Quality	Low Water Quality
Vegetation	National Importance		
	Unusual Stand Size	Common Stand Size	Minimal Stand Size
	Unusual Texture	Common Texture	Uniform Texture
	Unusual Seasonal Color	Moderate Seasonal Color	No Seasonal Color
	Unusual Forms	Common Forms	Continuous Forms

Source: USDA, Forest Service, Visual Management System, undated.

Foldouts

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Water Forms	National Importance		
	Unusual Size	Common Size	
Lakes	Unusual Shoreline	Common Shoreline	Uniform Shoreline
	High Water Quality	Average Water Quality	Low Water Quality
	Unusual Reflections	Common Reflections	No Reflections
Streams	National Importance		
	Unusual Motion	Common Motion	Still
	Unusual Configuration	Common Configuration	Uniform Configuration
	High Water Quality	Average Water Quality	Low Water Quality
Vegetation	National Importance		
	Unusual Stand Size	Common Stand Size	Minimal Stand Size
	Unusual Texture	Common Texture	Uniform Texture
	Unusual Seasonal Color	Moderate Seasonal Color	No Seasonal Color
	Unusual Forms	Common Forms	Continuous Forms

Sources: USDA, Forest Service, Visual Management System, Undated.

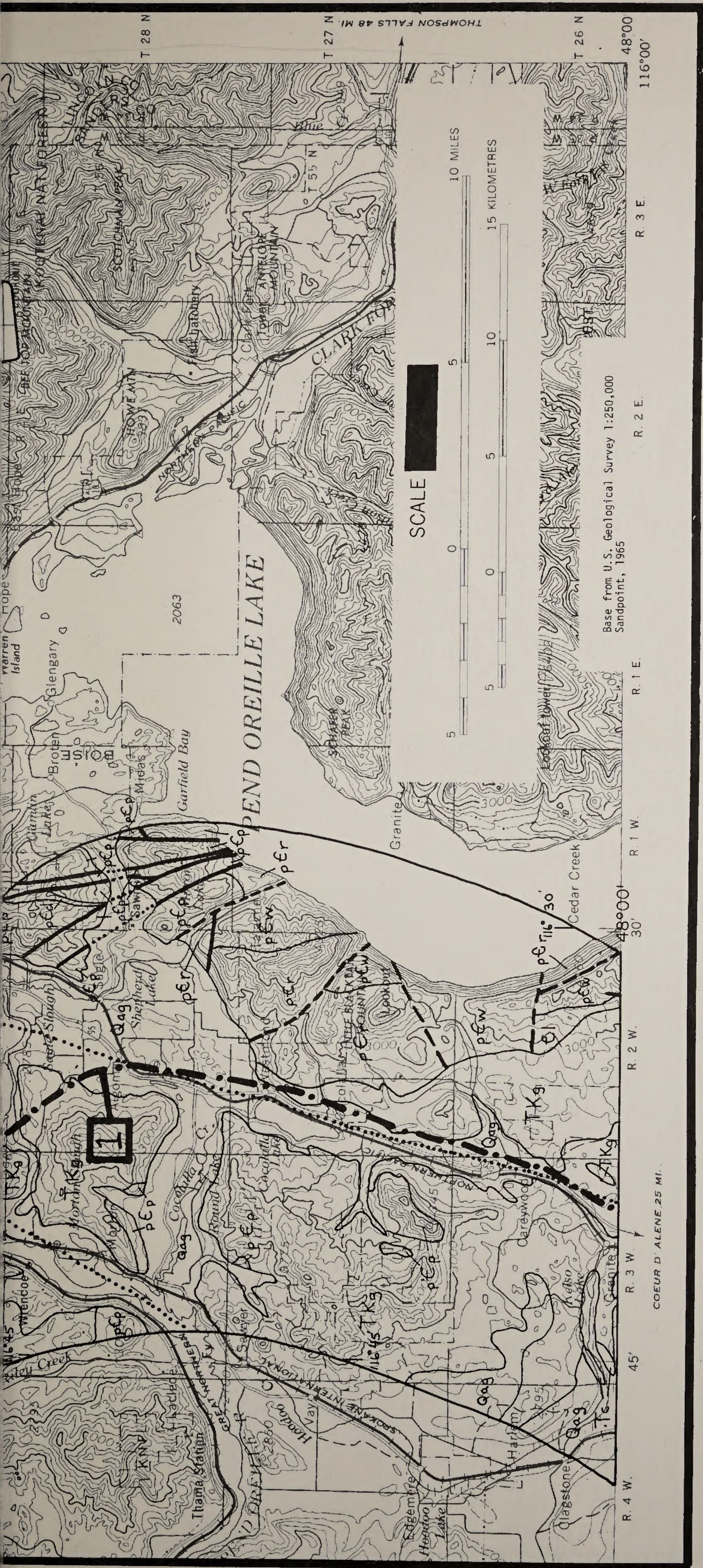


Figure 2.1.4.3-2 Gelogical strip map (Sandpoint)

Water Forms	National Importance		
	Unusual Size	Common Size	
Lakes	Unusual Shoreline	Common Shoreline	Uniform Shoreline
	High Water Quality	Average Water Quality	Low Water Quality
	Unusual Reflections	Common Reflections	No Reflections
Streams	National Importance		
	Unusual Motion	Common Motion	Still
	Unusual Configuration	Common Configuration	Uniform Configuration
	High Water Quality	Average Water Quality	Low Water Quality
Vegetation	National Importance		
	Unusual Stand Size	Common Stand Size	Minimal Stand Size
	Unusual Texture	Common Texture	Uniform Texture
	Unusual Seasonal Color	Moderate Seasonal Color	No Seasonal Color
	Unusual Forms	Common Forms	Continuous Forms

Source: USDA, Forest Service, Visual Management System, undated.

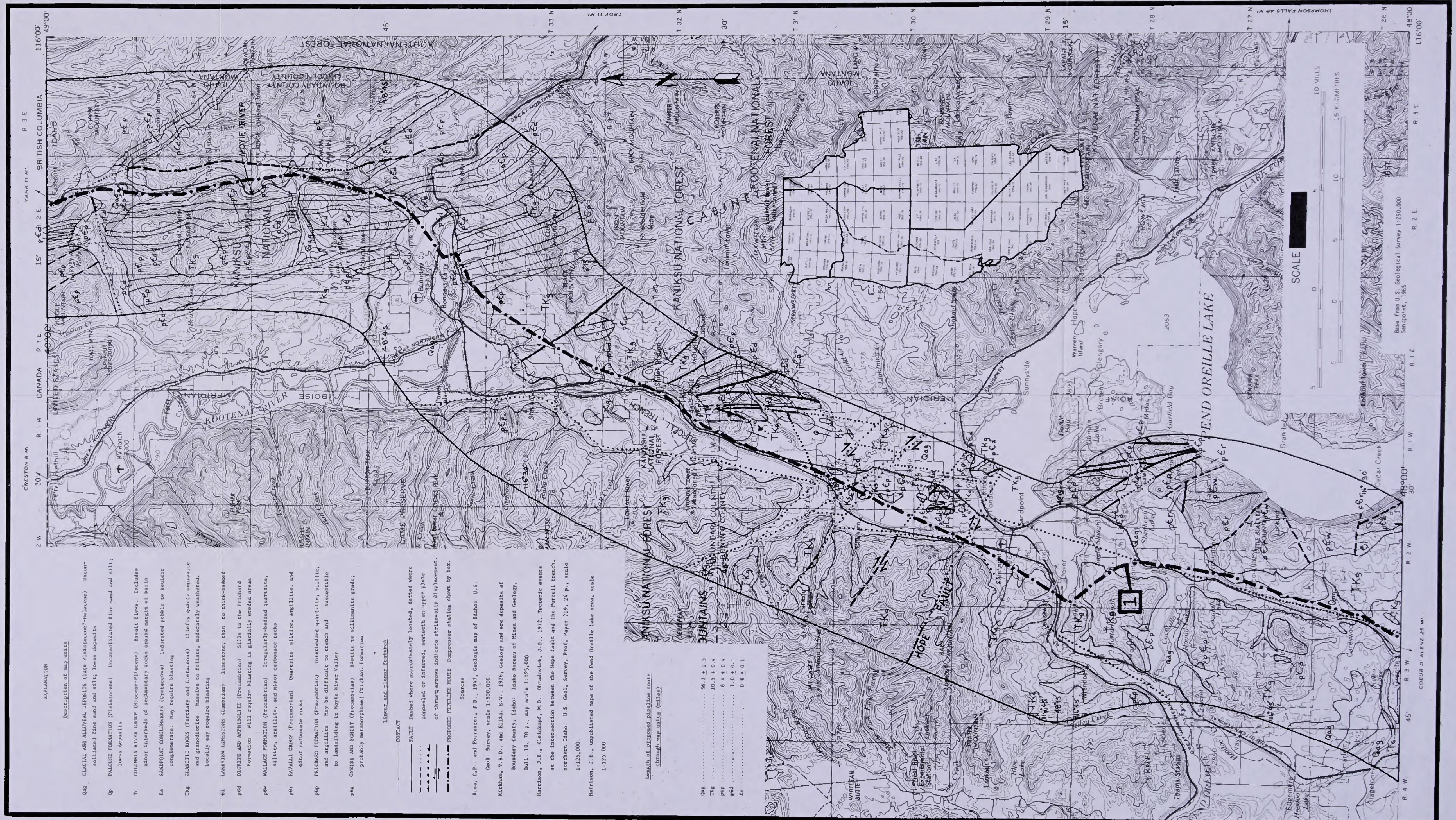


Figure 2.1.4.3-2 Gelogical strip map (Sandpoint)

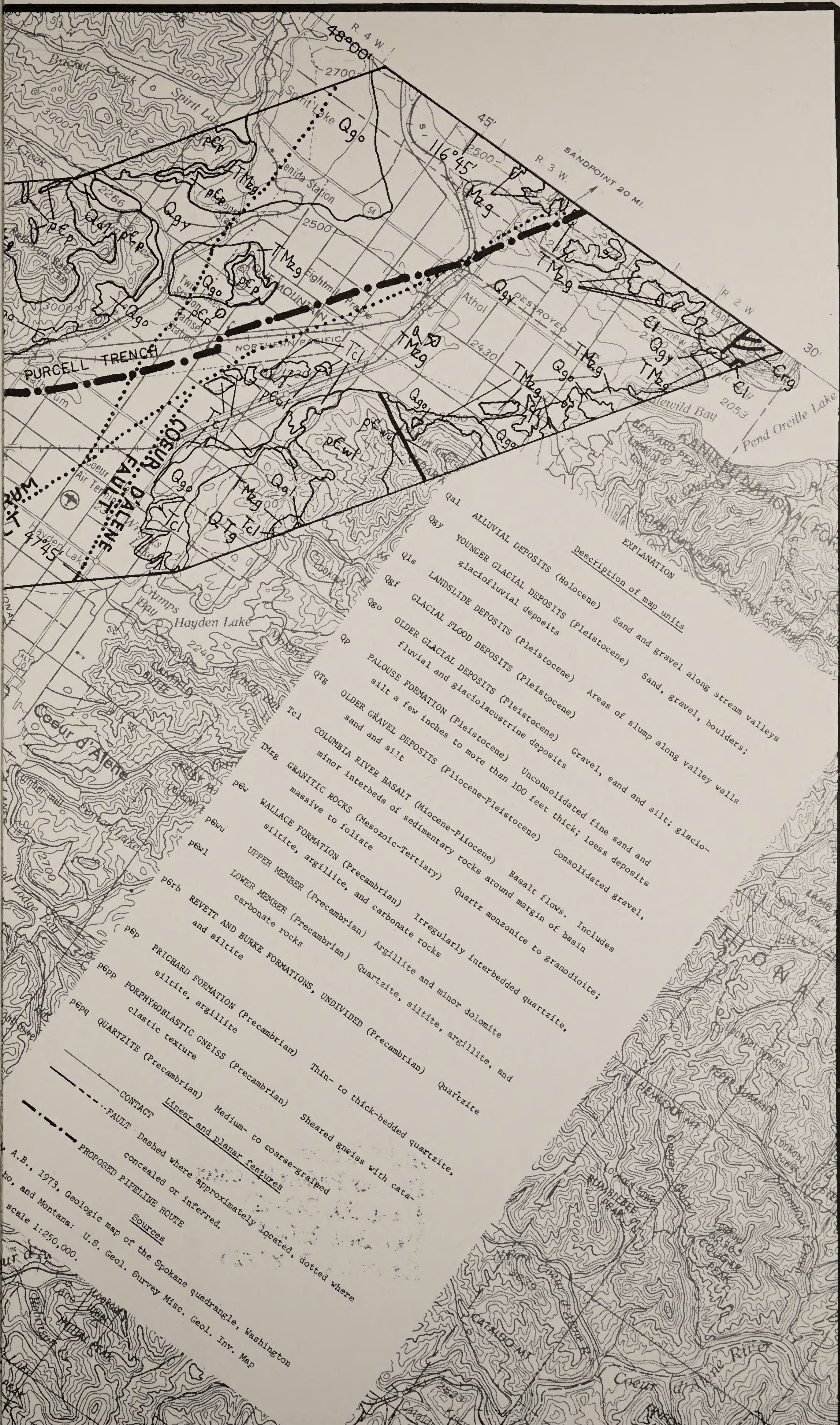
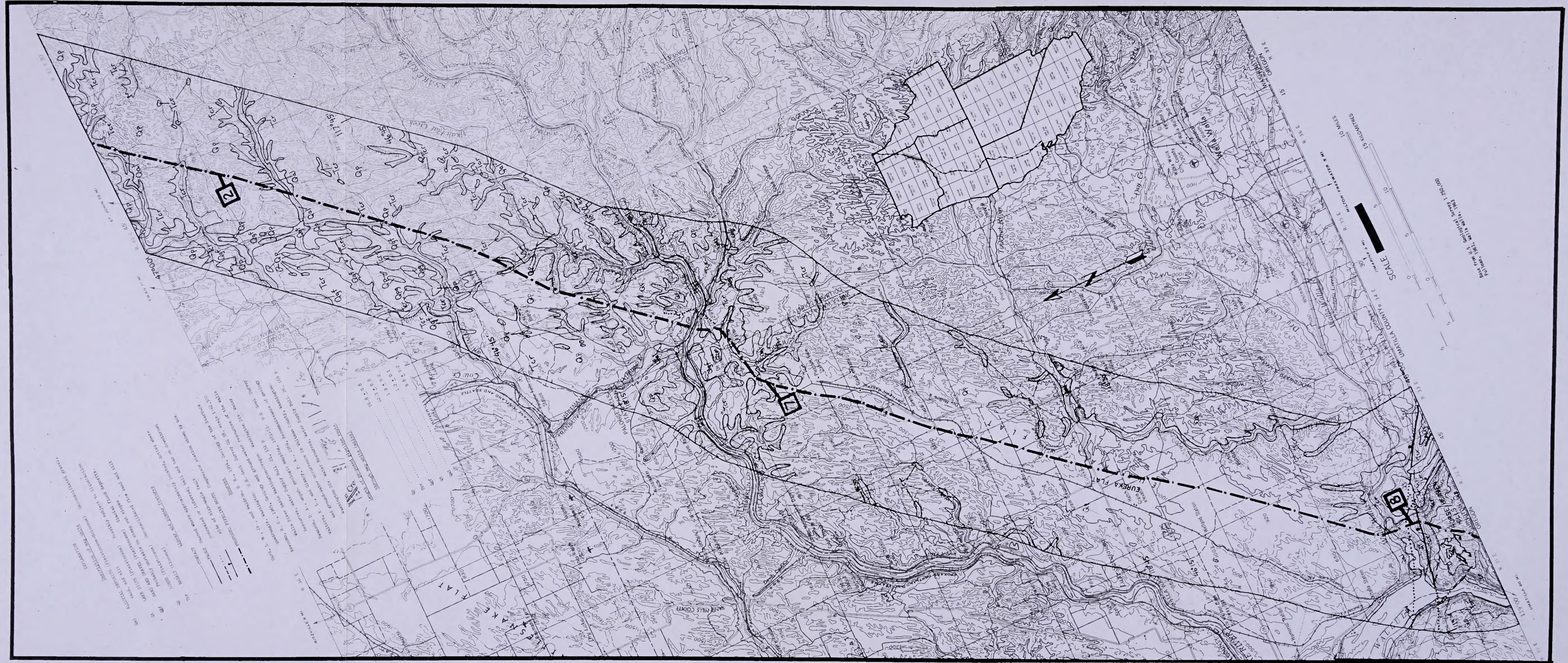


Figure 2.1.4.3-3 Geological strip map (Spokane)

Figure 2.1.4.3-3 Geological strip map (Spokane)

Figure 2.1.4.3-4 (Pullman-Walla Walla)



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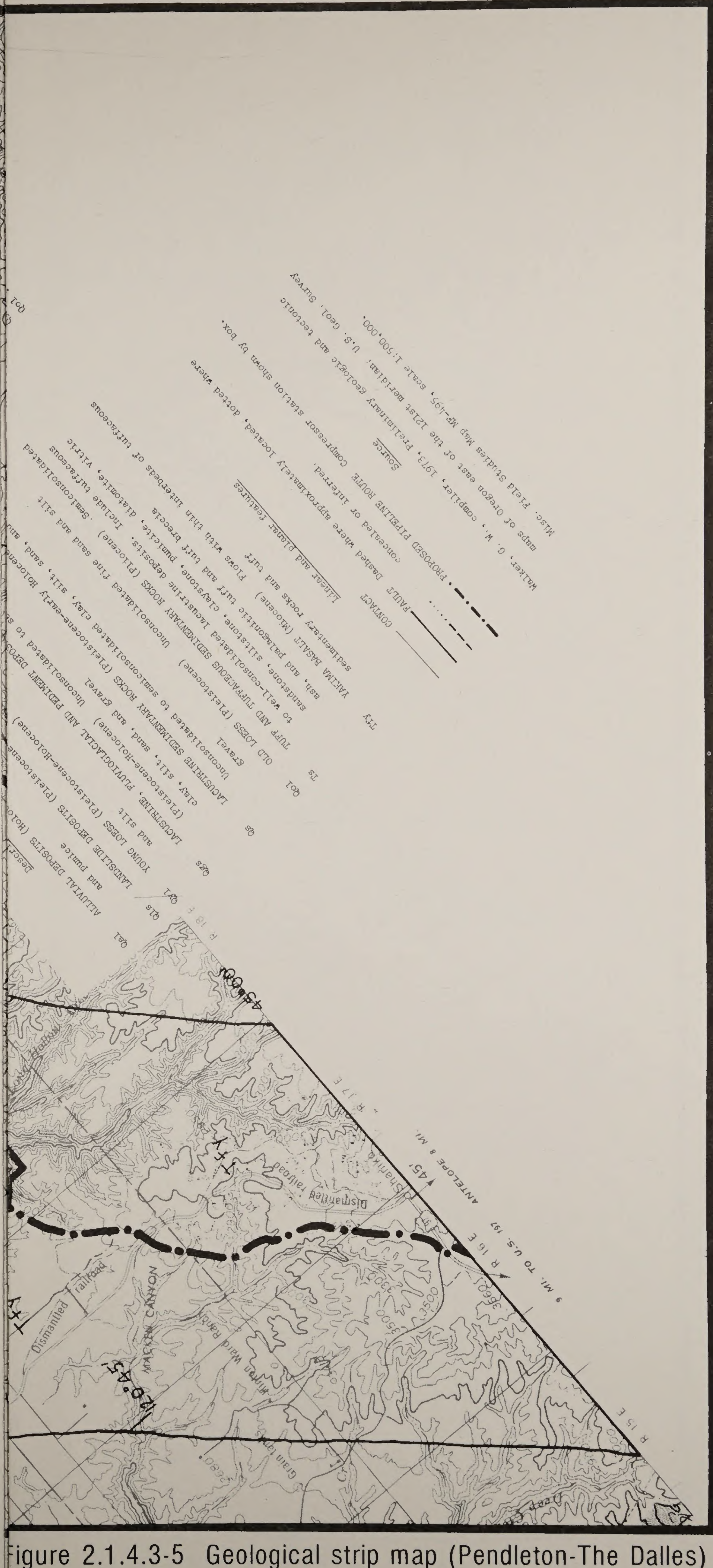


Figure 2.1.4.3-5 Geological strip map (Pendleton-The Dalles)

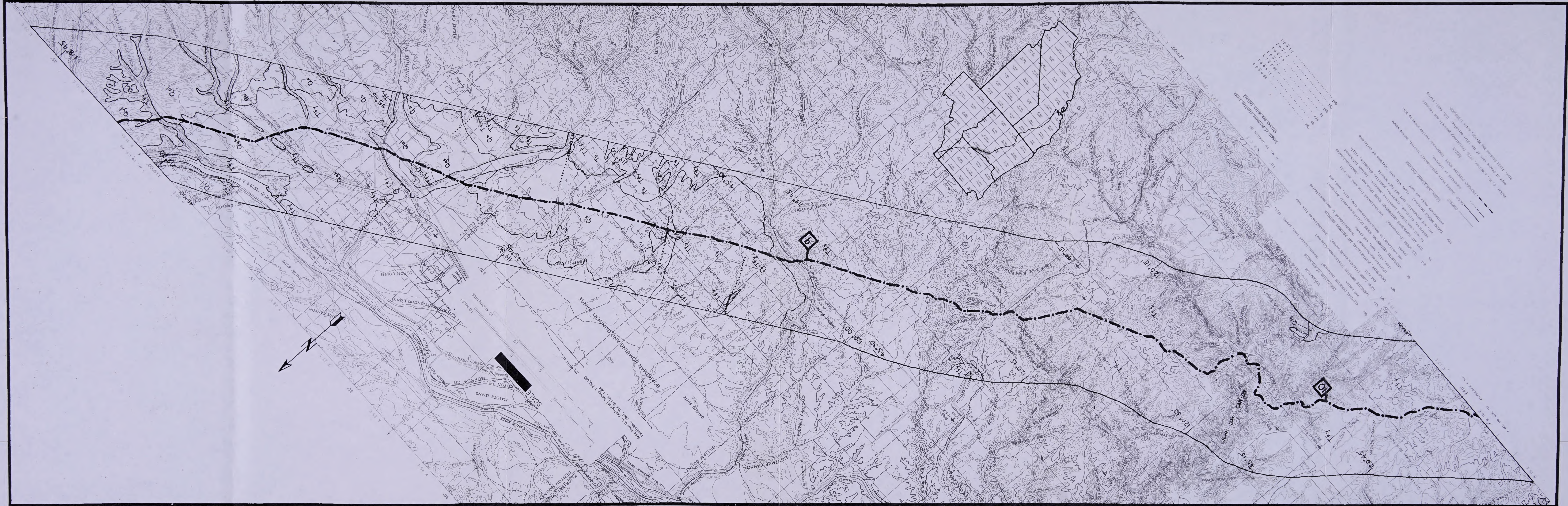


Figure 2.1.4.3-5 Geological strip map (Pendleton-The Dalles)

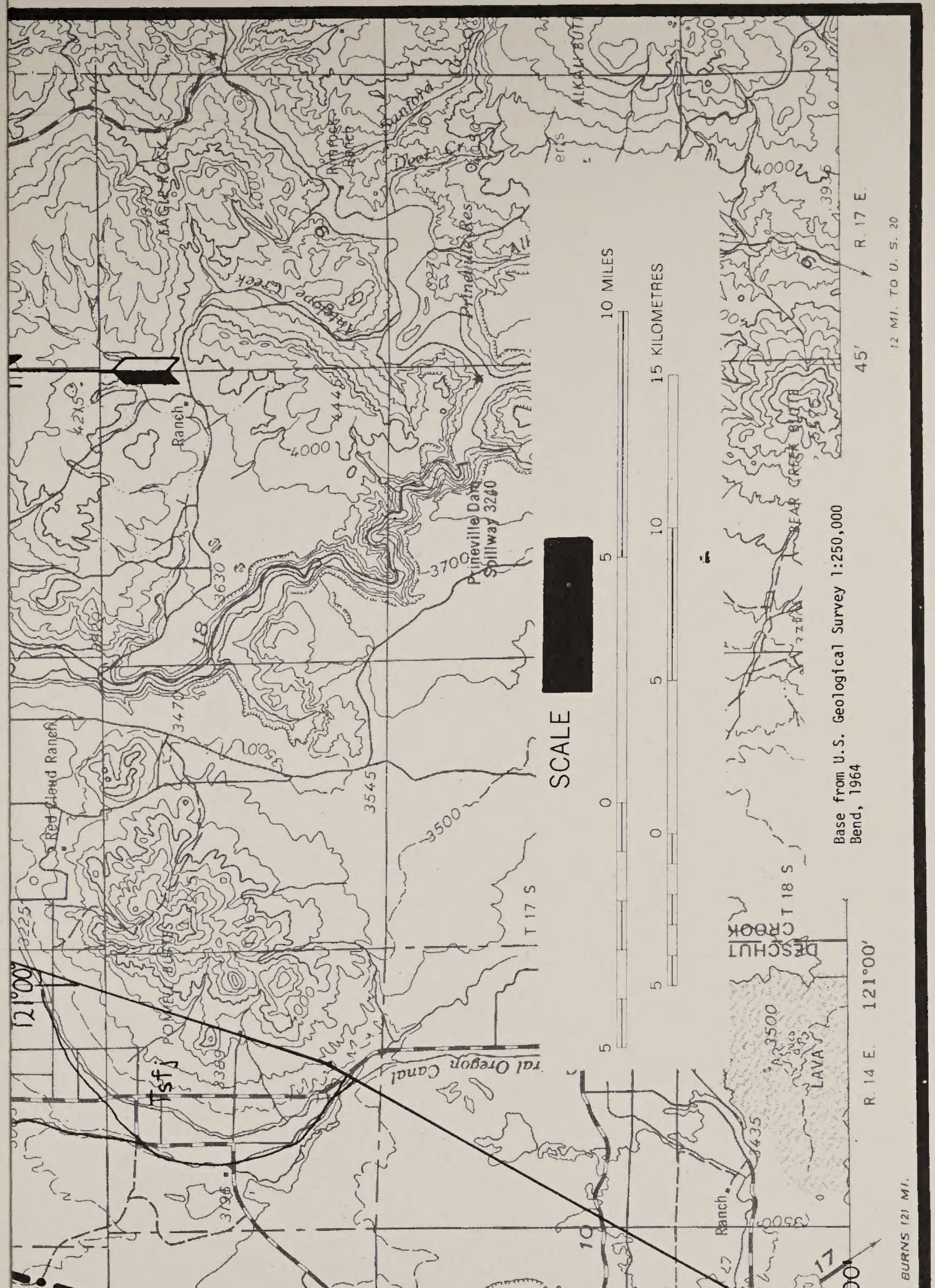


Figure 2.1.4.3-6 Geological strip map (Bend)

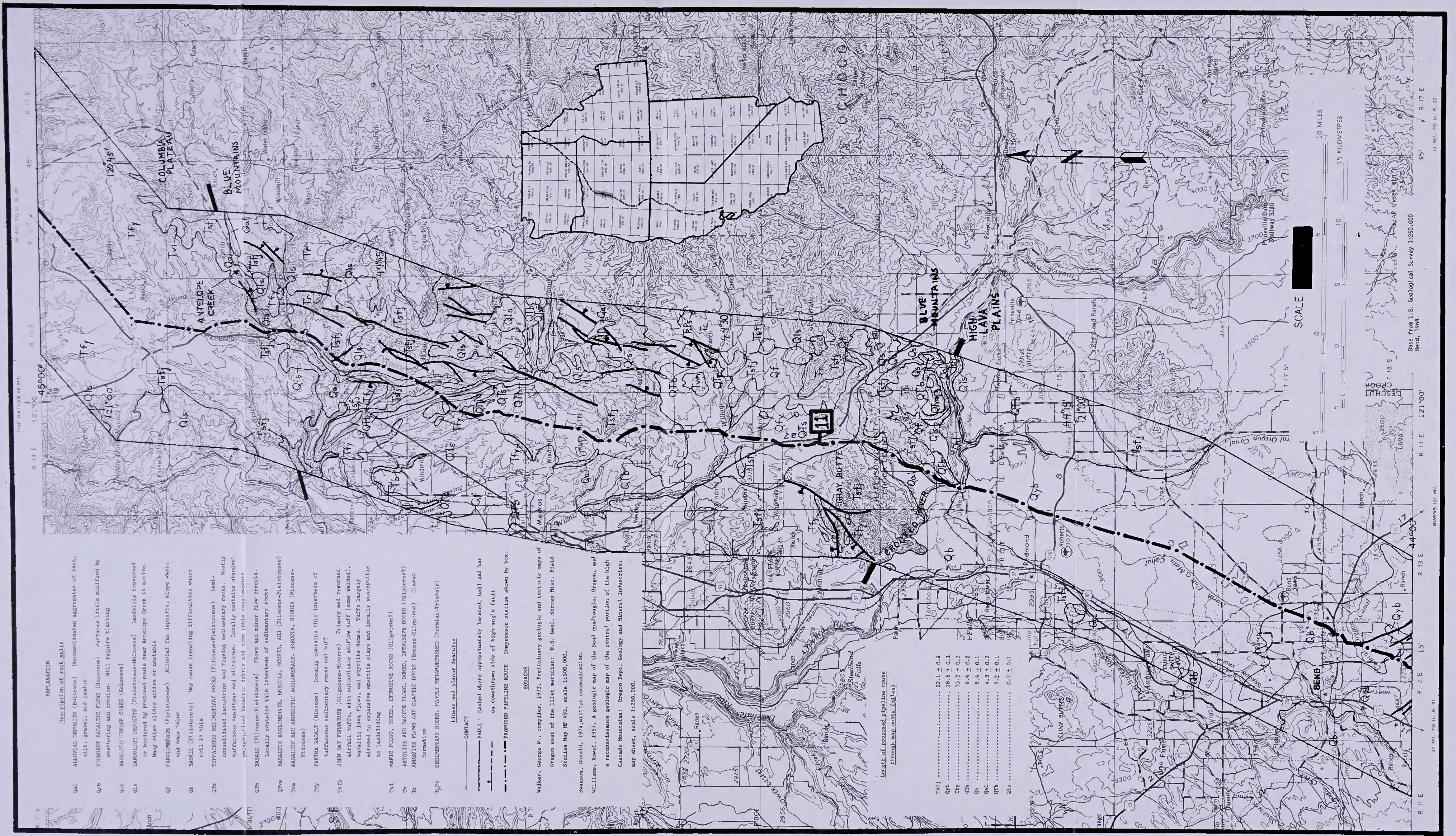


Figure 2.1.4.3-6 Geological strip map (Bend)

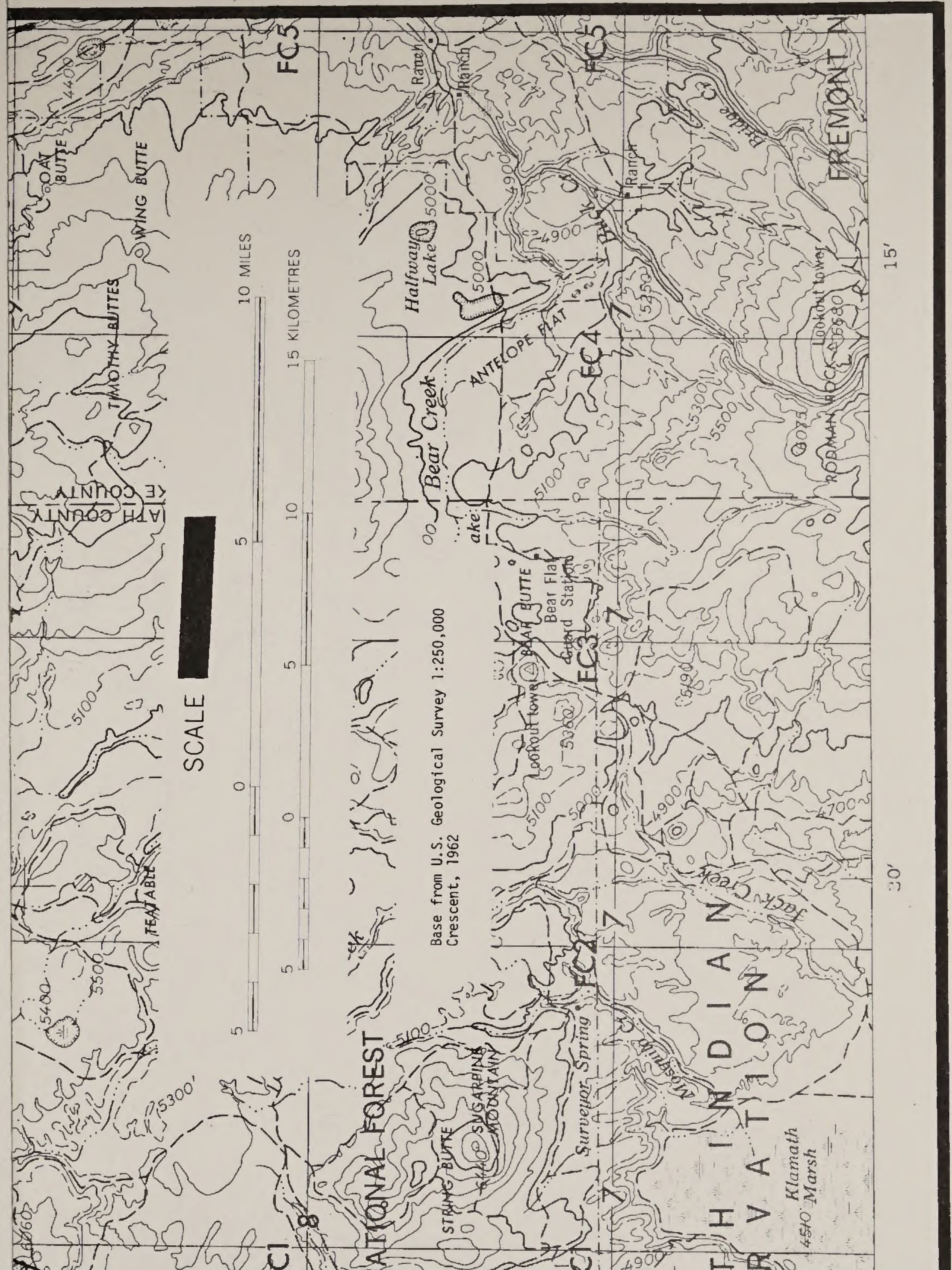


Figure 2.1.4.3-7 Geological strip map (Crescent)

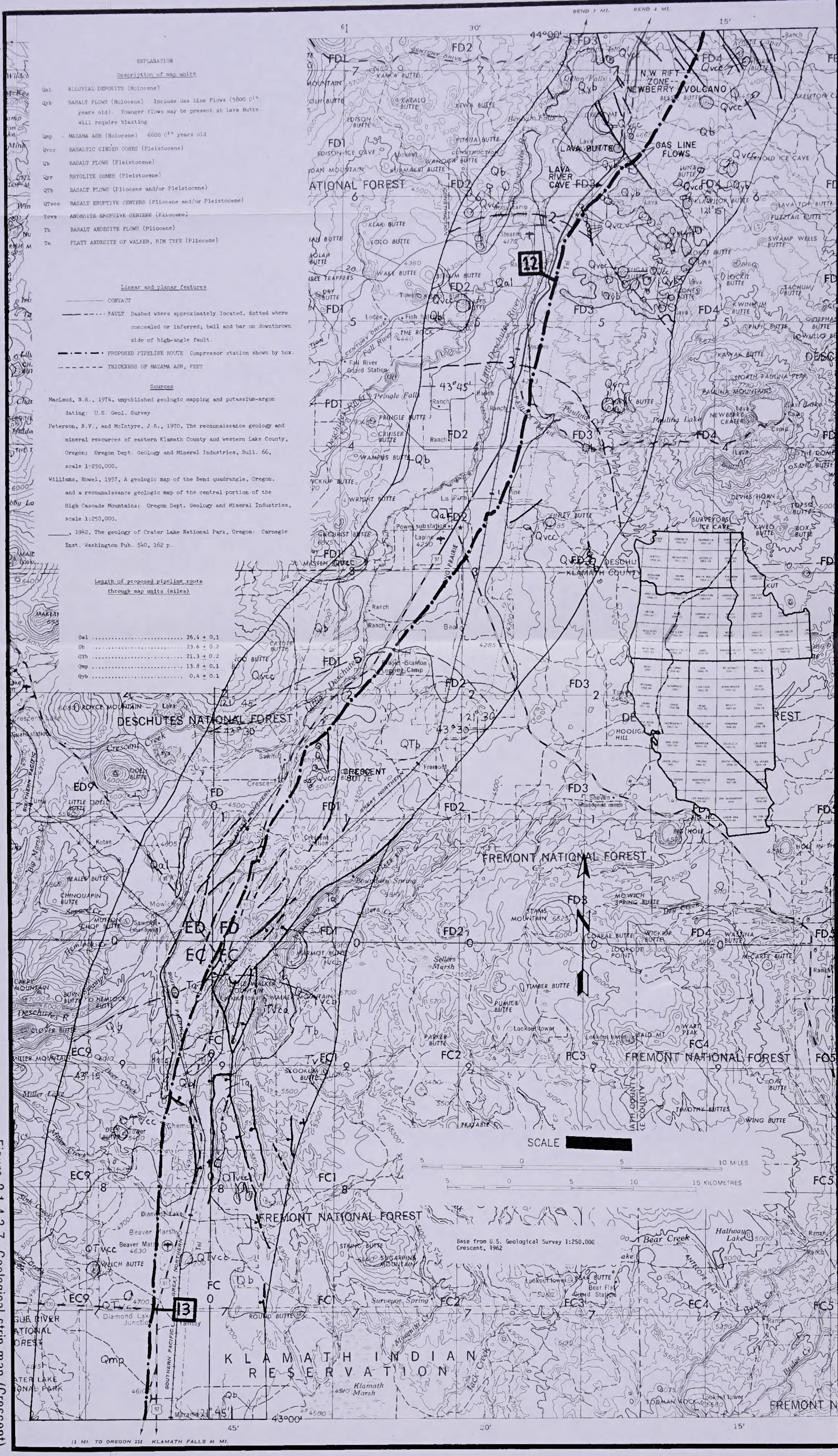


Figure 2.1.4.3-7 Geological strip map (Crescent)

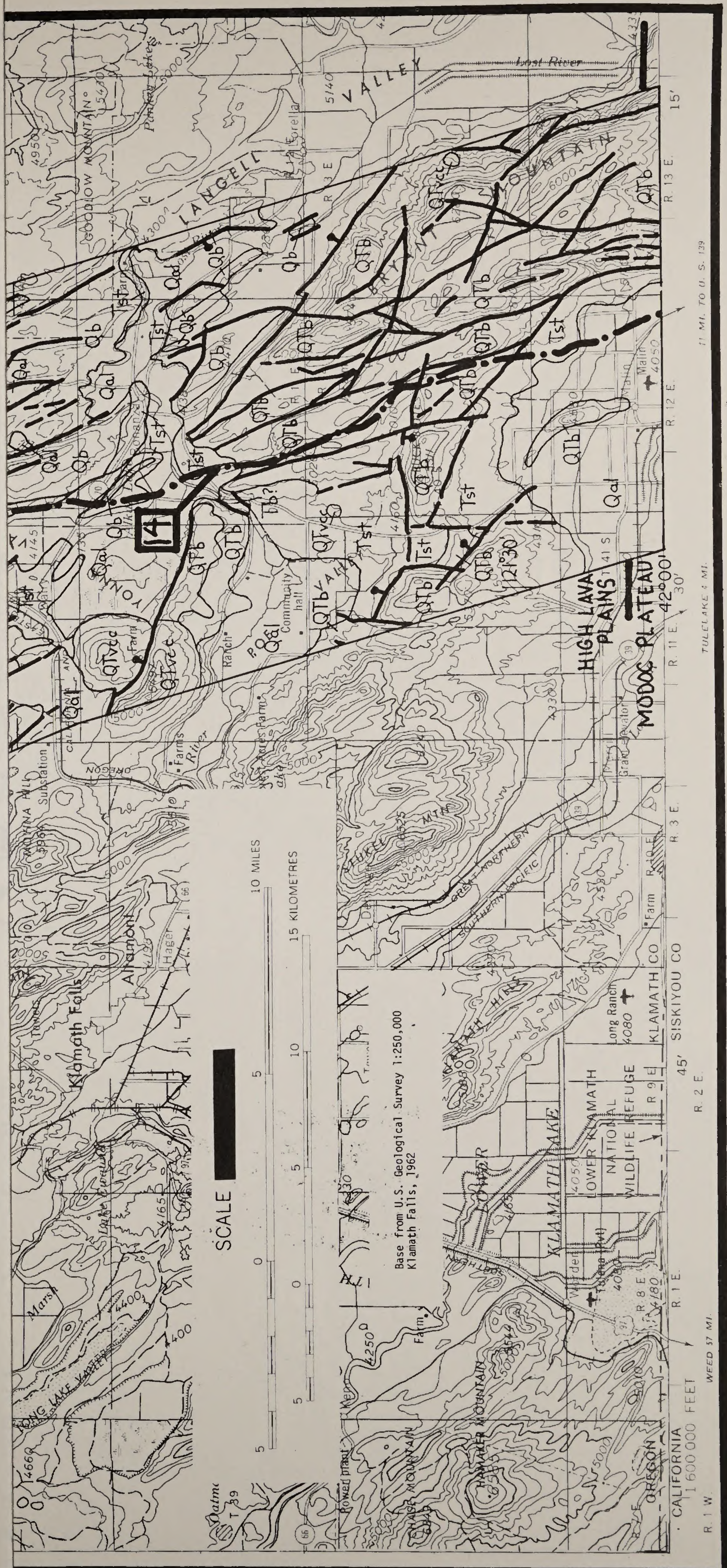


Figure 2.1.4.3-8 Geological strip map (Klamath Falls)

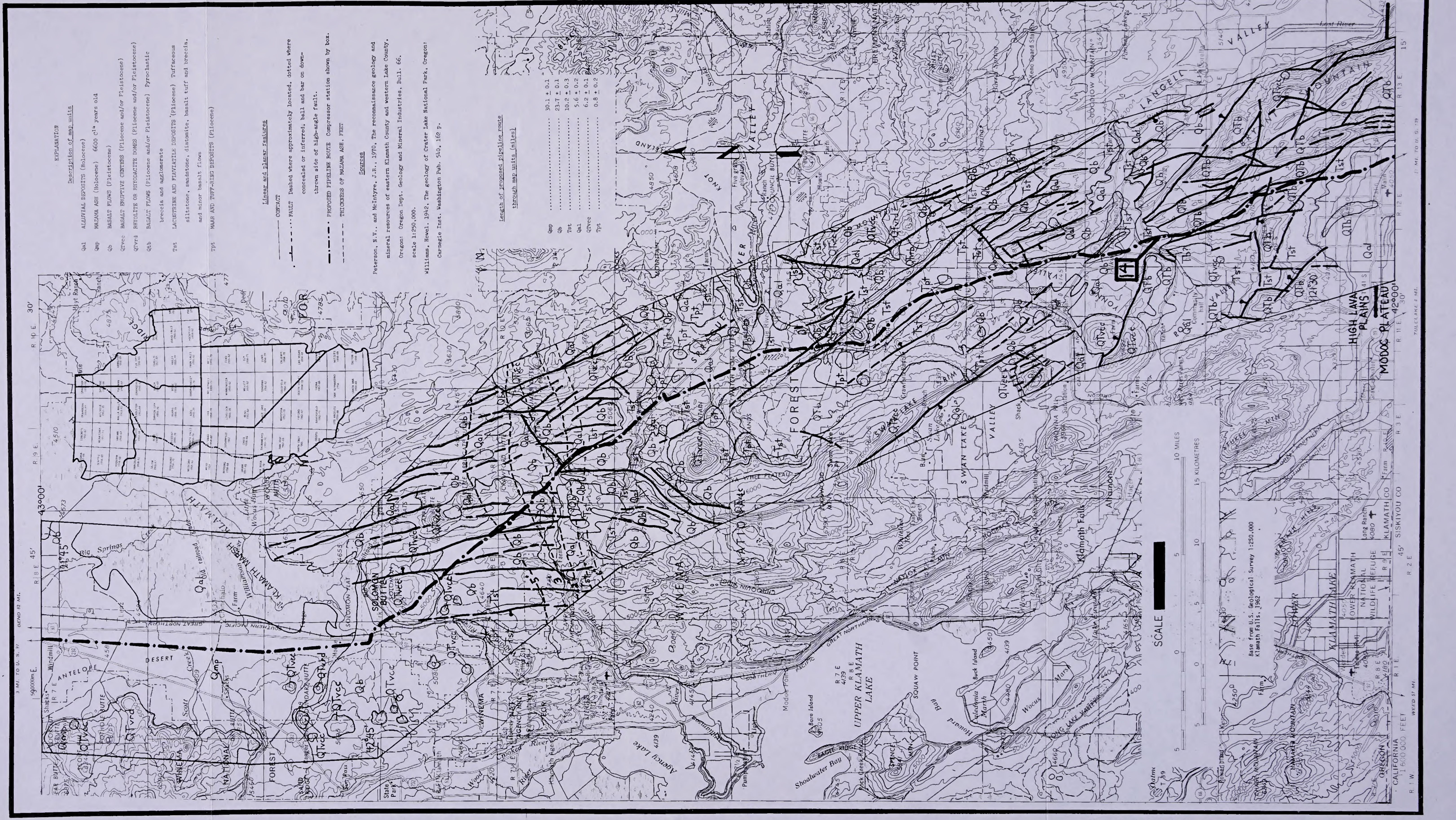


Figure 2.1.4.3-8 Geological strip map (Klamath Falls)

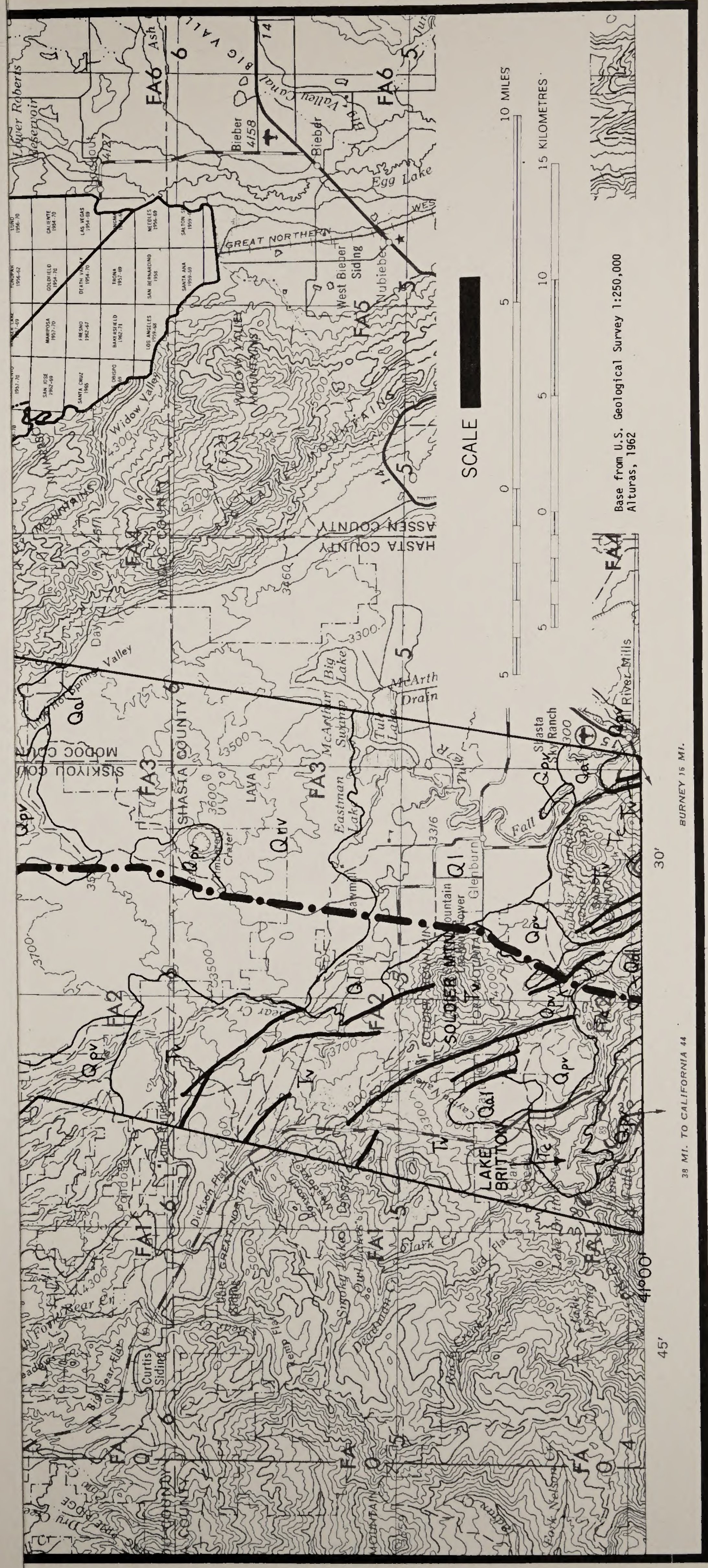


Figure 2.1.4.3-9 Geological strip map (Alturas)

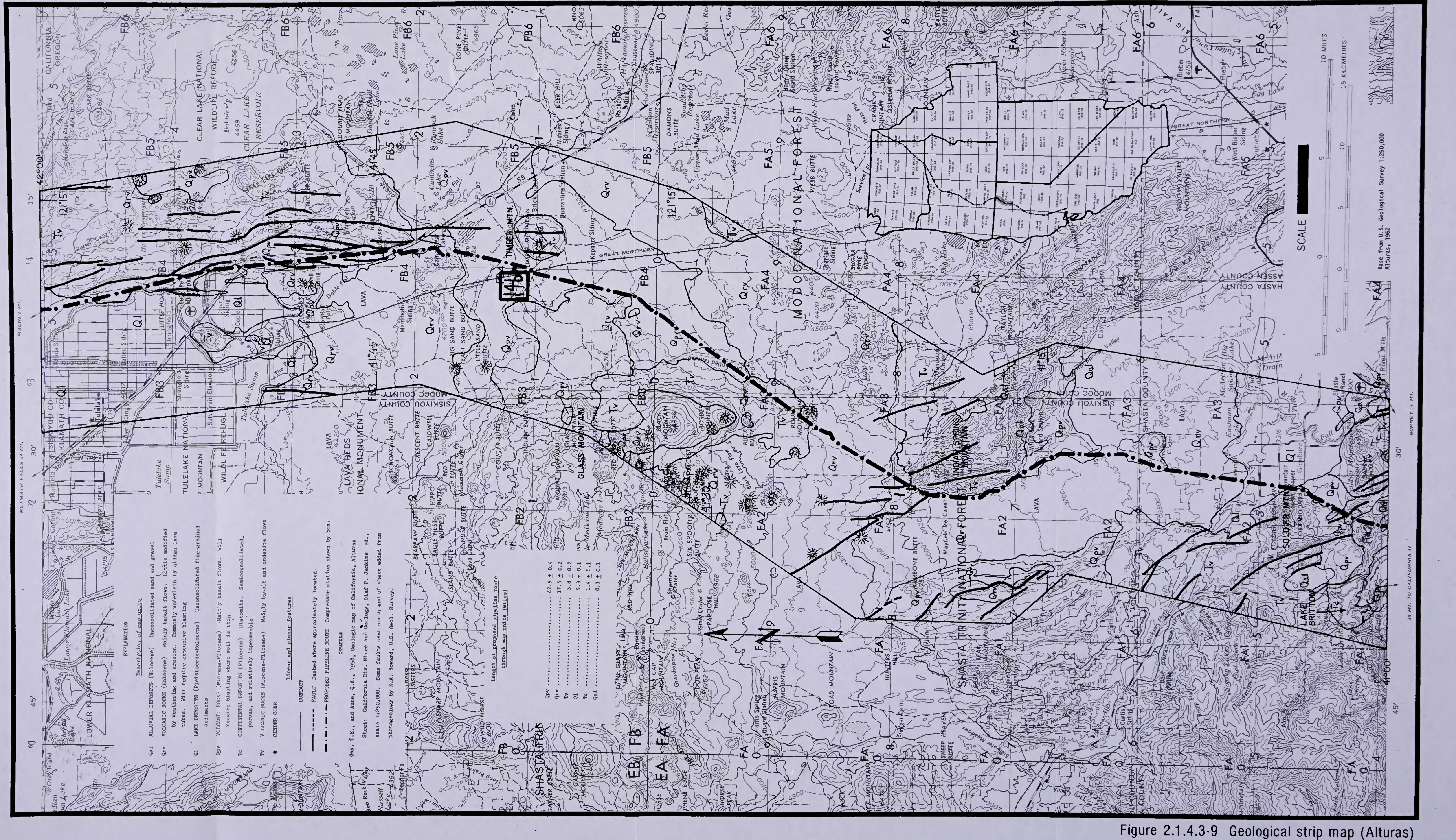


Figure 2.1.4.3-9 Geological strip map (Alturas)

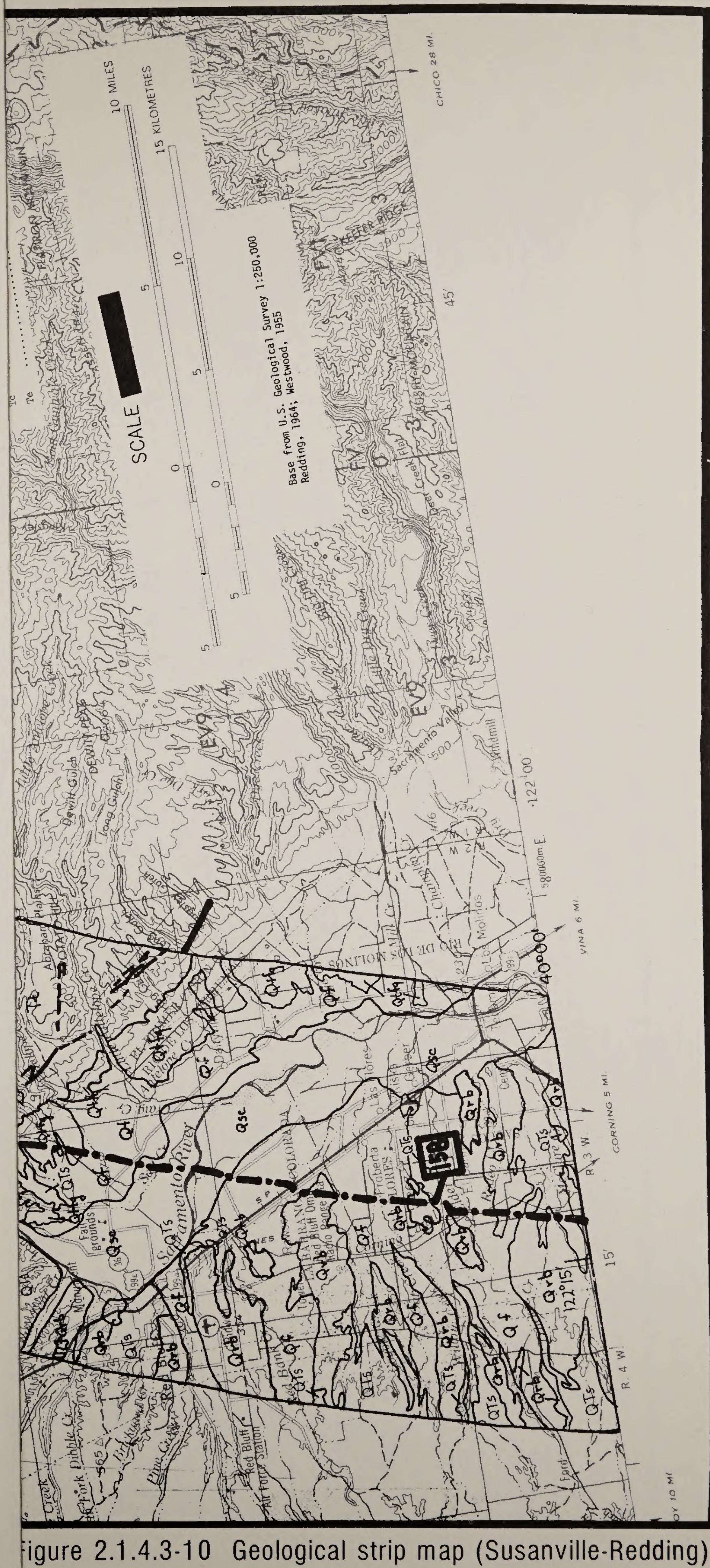


Figure 2.1.4.3-10 Geological strip map (Susanville-Redding)

Figure 2.1.4.3-10 Geological strip map (Susanville-Redding)

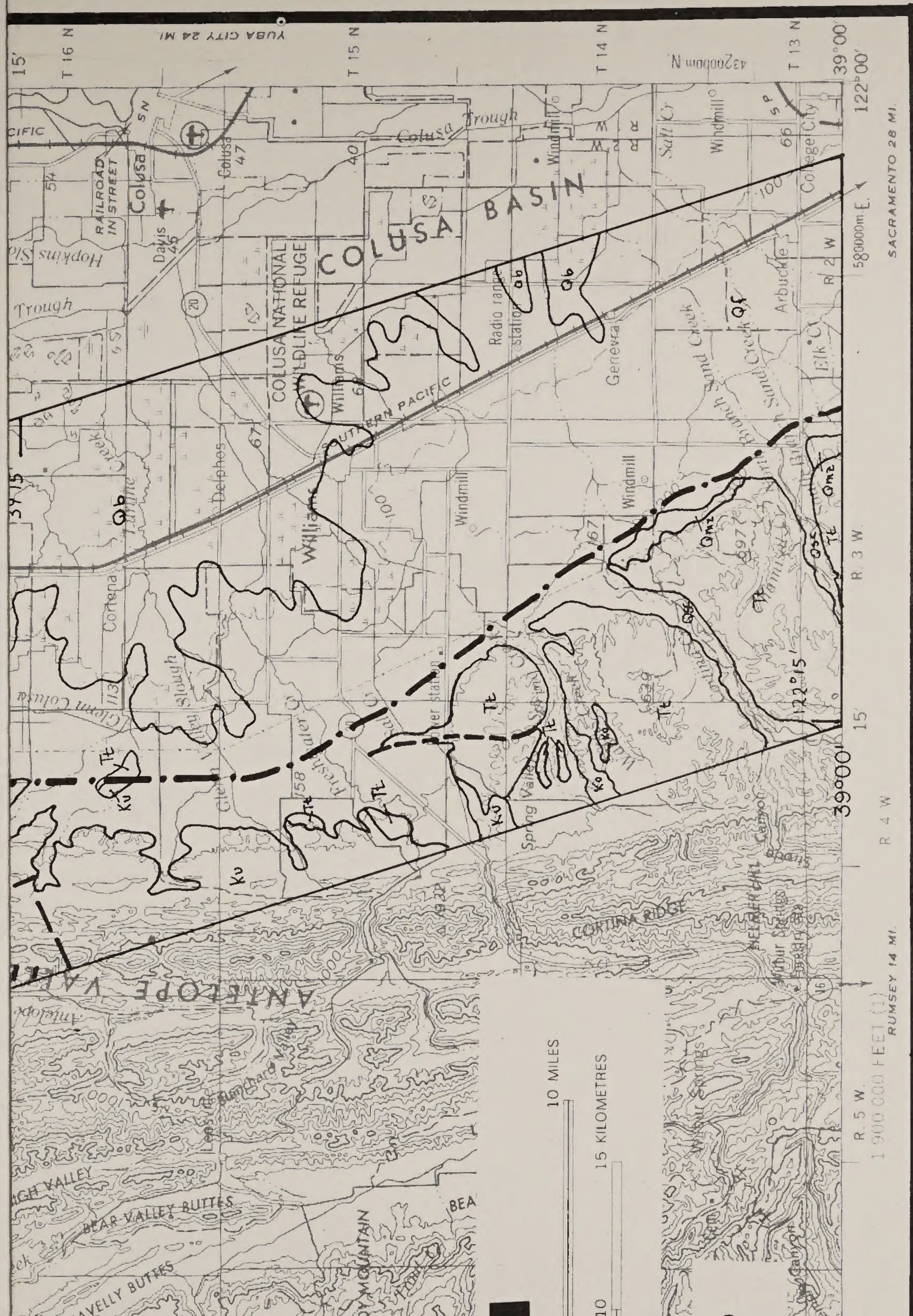


Figure 2.1.4.3-11 Geological strip map (Ukiah)

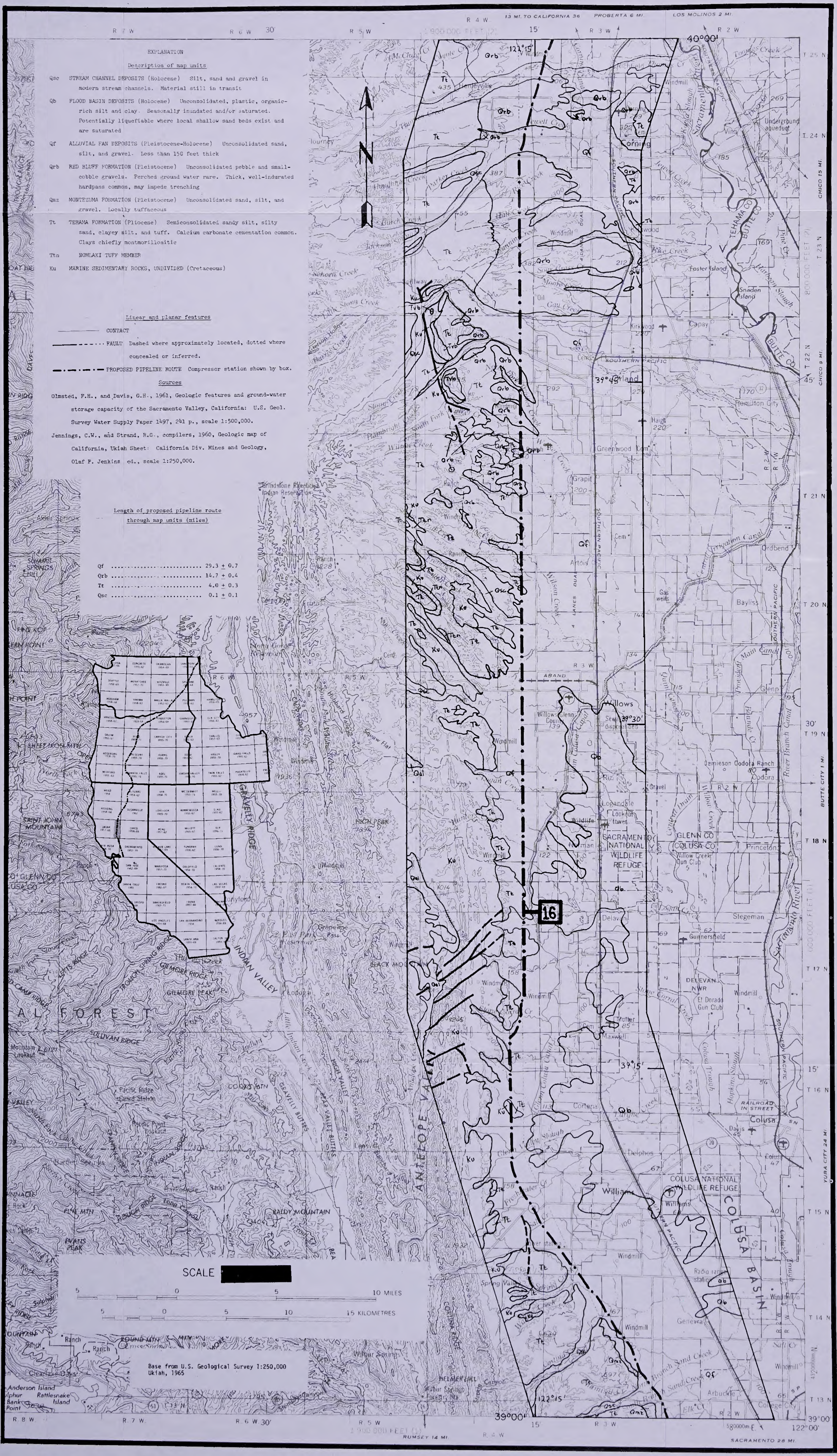
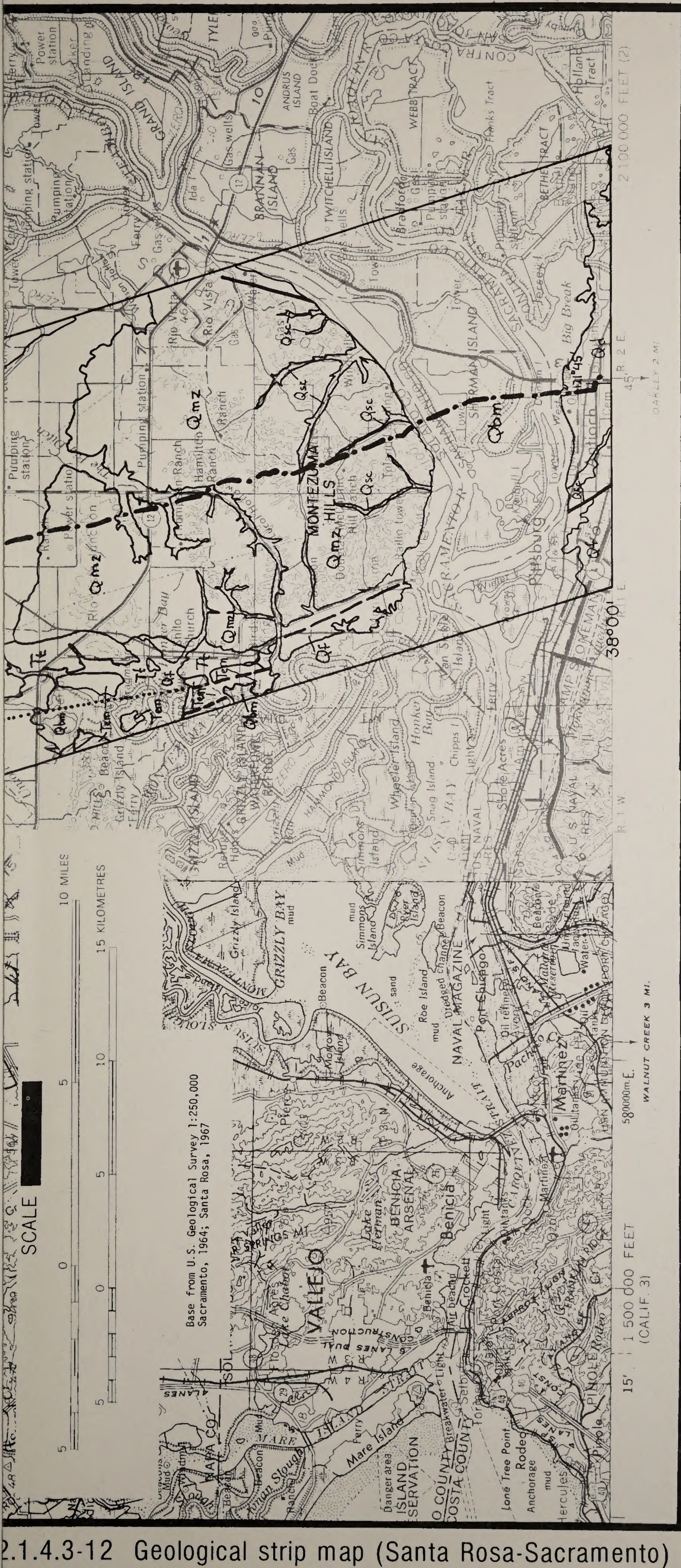


Figure 2.1.4.3-11 Geological strip map (Ukiah)



.1.4.3-12 Geological strip map (Santa Rosa-Sacramento)

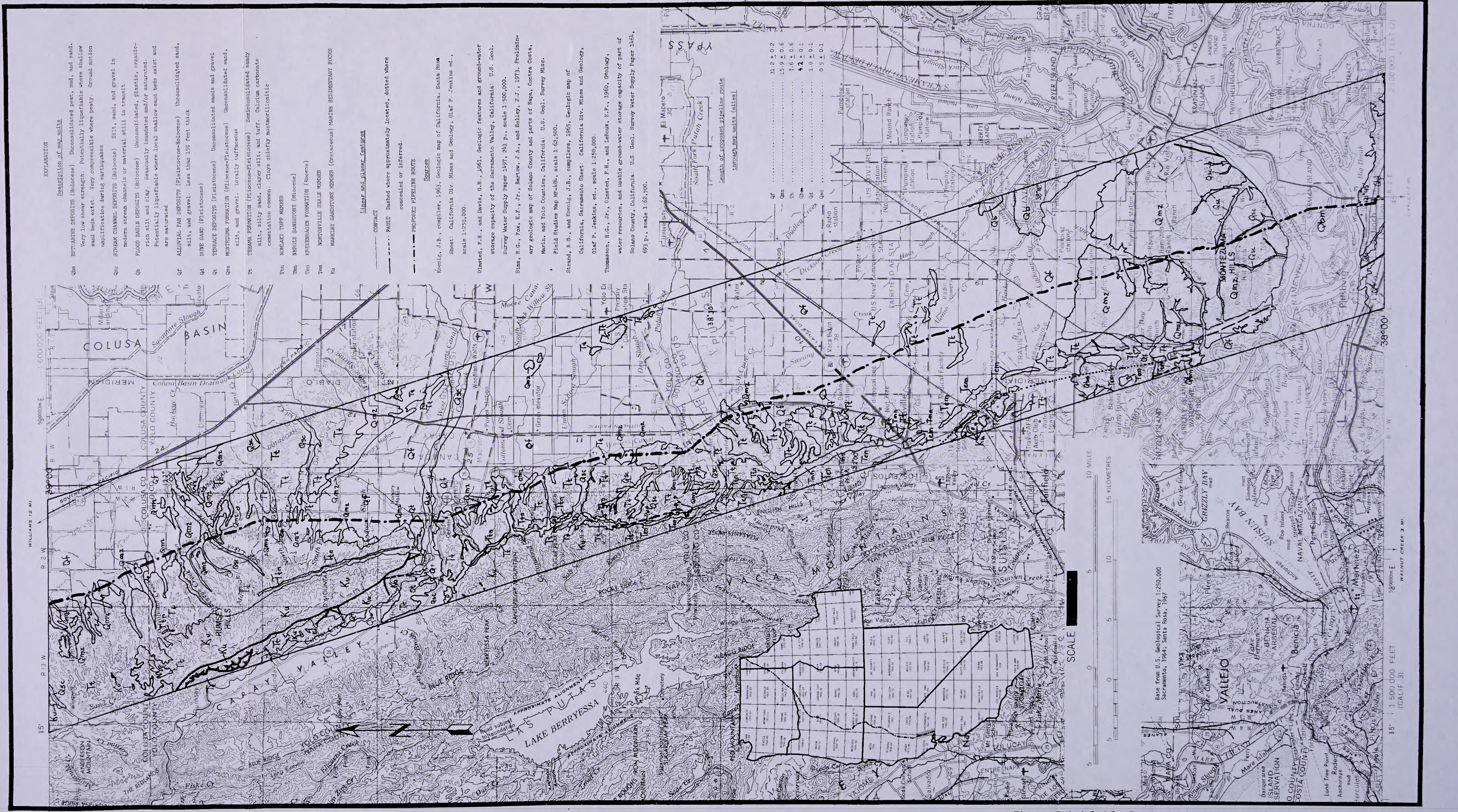


Figure 2.1.4.3-12 Geological strip map (Santa Rosa-Sacramento)

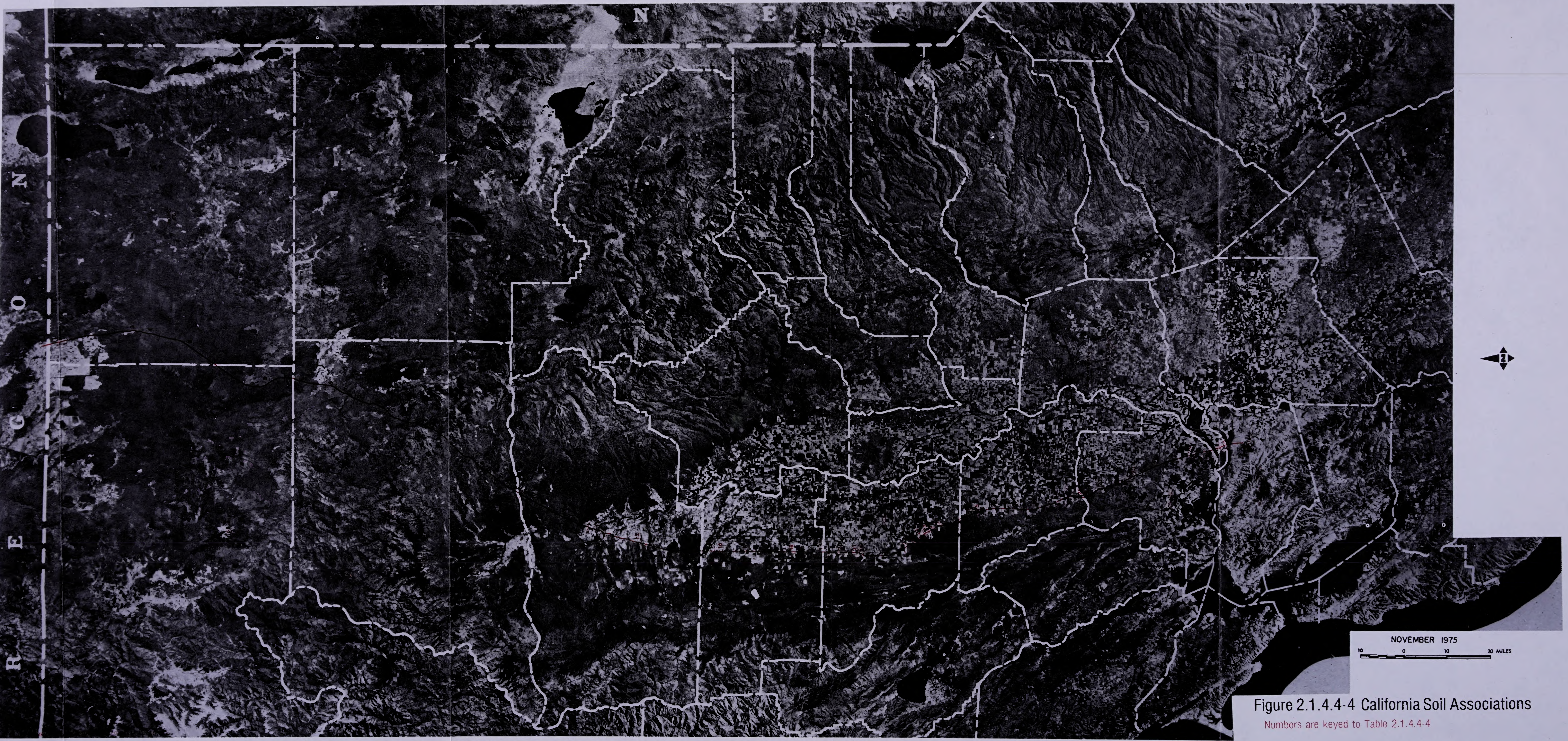


Figure 2.1.4.4-4 California Soil Associations

Numbers are keyed to Table 2.1.4.4-4